

EMCSF
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Remedial Investigation/Feasibility Study

Preliminary Site Characterization Summary

Volume III

Sections 4.4-4.6, 5

Prepared for:
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for the
Eastern Michaud Flats Site

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Bechtel Environmental, Inc.



PSCS Overall Contents

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4.4 GROUNDWATER

This section describes the nature and extent of impacted groundwater with respect to potential sources within the EMF study area. It compares the concentrations of constituents detected in samples from wells within the EMF study area with representative concentrations of these constituents to assess the general magnitude of site-related impacts. It also describes the areal dimensions of impacted groundwater.

Section 4.4.1 presents a characterization of groundwater quality unaffected by potential releases from the EMF facilities. This is referred to as representative groundwater quality. Sections 4.4.2 through 4.4.5 continue with a discussion of the nature and extent of impacted groundwater organized by geographic areas within the EMF study area; these areas encompass groups of potential sources. Section 4.4.2 discusses groundwater quality beneath two parts of the FMC facility. The former ponds in the southwestern FMC facility area are discussed as an area distinct from the central FMC facility area. This is done because groundwater emanating from the area of the former ponds in the southwestern area flows beneath the central FMC area.

The next area discussed (in Section 4.4.3) is the eastern and central Simplot facility. This area includes most of the upper gypsum stack, the lower gypsum stack, and the former east overflow pond. The joint fenceline area—an area including land on both the FMC and Simplot facilities properties—is discussed in Section 4.4.4. This area is discussed separately because of the commingling of flow patterns and constituents within the relatively complex hydrogeologic setting in this area. The final geographic area is the offsite area, which encompasses the area beyond the facilities' north fencelines (Section 4.4.5).

Further evaluation of the hydraulic influence of potential sources and onsite pumping wells on groundwater flow patterns is in progress. The results of this study will be included in the RI report. Until this evaluation is completed, it is premature to draw conclusions regarding the relative level of contribution from potential sources to the observed levels of constituents in offsite wells or in areas where flows from several areas have commingled.

Figures 4.4-1 through 4.4-5 illustrate the distribution of arsenic, orthophosphate, pH, sulfate, and total phosphorus in groundwater throughout the EMF study area. These figures provide an overview of the nature of site-related constituents that will be described in greater detail in Sections 4.4.2 through 4.4.5. Figure 4.4-6 outlines the five geographical areas referred to throughout this section.

An overview of Section 4.4 is provided on the following page.

Overview of Section 4.4
Nature and Extent of Constituents of Potential Concern in Groundwater

| | | | | |
|--|--|---|---|---|
| Representative Groundwater Quality <i>(Section 4.4.1):</i> | <ul style="list-style-type: none">■ Sixteen upgradient wells define representative concentrations.■ Three hydrogeochemical regimes are present.■ Constituent levels are low. | | | |
| Characteristics of Onsite Groundwater Quality | <table><tr><td>FMC Facility <i>Section 4.4.2</i></td><td>Simplot Facility <i>Section 4.4.3</i></td><td>Joint Fenceline Area <i>Section 4.4.4</i></td></tr></table> <ul style="list-style-type: none">■ Organic compounds are largely not present, and most metals are within representative concentrations.■ Shallow groundwater has been impacted by releases from unlined waste management units at both facilities.■ Primary site-related constituents of potential concern appear to be arsenic, chloride, fluoride, nitrate, selenium, sodium, and sulfate.■ Areas of impact at FMC are in the vicinity of former unlined ponds (phossy waste, kiln and calciner scrubbers) and slag pit.■ Areas of impact at Simplot are the gypsum stacks and former east overflow pond.■ Several potential sources may contribute constituents within the joint fenceline area.■ Closures of unlined waste management units at both facilities have greatly reduced constituent releases; this will quickly lead to improved groundwater quality. | FMC Facility <i>Section 4.4.2</i> | Simplot Facility <i>Section 4.4.3</i> | Joint Fenceline Area <i>Section 4.4.4</i> |
| FMC Facility <i>Section 4.4.2</i> | Simplot Facility <i>Section 4.4.3</i> | Joint Fenceline Area <i>Section 4.4.4</i> | | |
| Characteristics of Offsite Groundwater Quality <i>(Section 4.4.5):</i> | <ul style="list-style-type: none">■ Impact on groundwater offsite is limited, due to natural attenuation, dilution, and the influence of onsite production wells at Simplot.■ Groundwater that escapes the influence of Simplot's production wells may discharge, in part, at two springs near the Portneuf River (Batiste Spring and Swanson Road Spring). It appears that both facilities contribute flow to these springs. The relative contribution of constituents has not been determined. | | | |

Overview of Findings

Representative Groundwater

After piezometric groundwater contour maps were evaluated for the site during Phase I of the field investigation, 16 upgradient or crossgradient wells were selected as representative wells. Through an evaluation of the water chemistry in these wells using Stiff and Piper diagrams, three distinct water chemistries (uninfluenced by EMF facility activities) were identified in the aquifer. These have been designated the Michaud Flats, Bannock Range, and Portneuf River Valley hydrogeochemical regimes.

While there are some differences between these regimes in their trace metal content, the primary differences are in general water quality parameters (sodium, potassium, calcium, magnesium, chloride, bicarbonate, and sulfate). The groundwater in the Michaud Flats regime is more saline (higher chloride and sodium content) than the other two regimes. The Bannock Range regime, which underlies most of the facilities area, has a calcium-bicarbonate chemistry and has the lowest ionic strength of the group. The Portneuf River Valley regime is also a calcium-bicarbonate system but is higher in bicarbonate.

The constituents detected in these 16 wells over multiple sampling events have been used to define groundwater quality that has not been influenced by potential releases from sources within the EMF facilities.

The term representative has been chosen instead of background in recognition of the fact that the shallow aquifer in this region has been impacted by anthropogenic activities other than those conducted by the facilities. This is especially evident in the Portneuf River Valley regime where higher nitrates and sulfates as well as a low-level tetrachloroethene plume are evidence of upgradient sources of constituents originating in the valley to the southeast (upgradient) of the EMF facilities.

FMC Southwestern and Central Areas

Groundwater has been impacted in the southwestern and central areas at the FMC facility. Eleven former, unlined ponds are located in the southwestern area. Five of the former phosphy waste ponds (Ponds 00S, 0S, 1S, 2S, and 3S) and the main plant area are located in the central area.

Impacted groundwater in the southwestern area appears to migrate north, transported by Bannock Range flow. However, this flow merges with a more east to-northeast-flowing Michaud Flats groundwater. The result is a mixing of the unimpacted—but more saline—Michaud Flats water with the impacted Bannock

Range water. This mixing has a diluting effect, as well as causing a general change in flow direction of the impacted groundwater toward the northeast. This confluence also has the net effect of preventing impacted water from leaving the site to the north. The constituents found in the impacted water at above-representative concentrations were arsenic, chloride, fluoride, orthophosphate, potassium, total phosphorus, and sodium. In addition, gross alpha, gross beta, sulfate, ammonia, boron, calcium, cobalt, lithium, magnesium, selenium, and nitrate were detected at above-representative concentrations in some groundwater samples collected within these areas. The primary constituents of potential concern appear to be arsenic, selenium, fluoride, nitrate, sulfate, chloride, and sodium.

Impacted groundwater from the southwestern area commingles with part of the impacted groundwater present in the central area and appears to migrate beyond the facility fence line near Well 111, just north of the main plant area. This commingled impacted groundwater continues northeast to east and may explain the presence of the arsenic detected in samples collected from the Old Pilot House well. At Well 111, arsenic was detected at a maximum concentration of 0.055 mg/l. Chloride was detected at a maximum concentration of 358 mg/l, and nitrate at a maximum concentration of 19.8 mg/l. These values are considerably lower than those found near the old pond sources and show the effects of attenuation and dilution that occur within the facility boundary.

Monitoring at the Old Pilot House well began in 1973 and continued through this investigation. This monitoring has shown that the quality of the groundwater has improved over the years. Arsenic values detected in samples collected between June 1992 and September 1993 ranged from 0.035 to 0.050 mg/l; chloride and nitrate values ranged from 250 to 263 mg/l and 9.6 to 18.4 mg/l, respectively.

Impacted groundwater in the central area has the same constituents of interest as the southwestern area except that trichloroethene was detected in some wells at very low levels (0.001 to 0.005 mg/l). Also, there are higher temperatures in the groundwater caused by the heating of soils from the slag pit operations. The higher temperature created by the slag pit operation creates a thermal plume that can be used to trace the pattern of groundwater flow. This impacted groundwater appears to migrate beyond the facility boundary in the vicinity of Well 146. There is a higher-than-expected temperature in Well 517 to the northeast. It appears that the groundwater thermal plume is drawn beyond the central area into the cone of depression and captured by the Simplot production wells.

Eastern and Central Simplot Area

Two sources of groundwater impact were identified at Simplot: the unlined gypsum stacks and the former, unlined east overflow pond. The former east overflow pond was active during the period of investigation and periodically

received discharges of plant process water during plant upset conditions. The impact of these discharges during an upset event could be detected in downgradient monitoring Well 318. This unlined pond was replaced with a lined unit in August 1993.

The constituents present at above-representative concentrations in groundwater beneath both the upper and lower gypsum stacks were ammonia, arsenic, bicarbonate, boron, calcium, lithium, magnesium, orthophosphate, potassium, reduced pH, total phosphorus, selenium, sodium, sulfate, and gross beta. Groundwater beneath the upper gypsum stack also contained elevated levels of gross alpha. Groundwater beneath the lower gypsum stack also contained elevated concentrations of fluoride and nitrate. The primary constituents of potential concern appear to be arsenic, selenium, fluoride, nitrate, sulfate, and sodium.

In the area of the former east overflow pond, constituents detected at above-representative concentrations were aluminum, ammonia, arsenic, beryllium, bicarbonate, boron, cadmium, calcium, total chromium, cobalt, copper, fluoride, lithium, magnesium, manganese, nickel, nitrate, orthophosphate, reduced pH, potassium, selenium, sodium, sulfate, thallium, and zinc.

Impacted groundwater originating from the gypsum stacks appeared to be largely captured by the Simplot production wells, which had a long-term average pumping rate of between 4,000 and 5,000 gpm. Based on preliminary analysis, it appears that some portion may have escaped capture by the production wells and flowed offsite. Further analysis using analytical modeling techniques is in progress to better understand the influence of the production wells on flow patterns. The results of this analysis will be included in the RI report.

Joint Fenceline Area

In the joint fenceline area, groundwater from the the western part of the gypsum stack flows in a gently northwesterly sweeping arc across the Simplot property boundary near the top (south) of the stack, passes under the calciner pond and former kiln scrubber overflow pond, and then flows back east toward the Simplot production wells. This "clockwise" flow appears to be paralleled to the north of the joint fenceline area by the flow pattern of the high-temperature groundwater originating beneath the FMC slag pit, which can be traced from Well 146 to Well 517. The groundwater in the joint fenceline area appears to commingle with constituents from the former (southwestern) ponds, and appears to be captured by the Simplot production wells.

While groundwater in some of the deeper wells within the facilities' property has shown impacts from facility operations, these impacts appear to be highly localized.

Offsite Area

There are site-related impacts to the north of the EMF facilities. These impacts do not extend beyond Interstate Highway 86 (I-86) to the north and west of FMC, but may appear in subdued form at Batiste Spring and Swanson Road Spring in the eastern portion of the EMF study area. There has also been impact at the Old Pilot House well, which was removed from service in 1976.

Historic data indicate that Batiste Spring and the Old Pilot House well water quality have improved as both facilities have changed their waste and byproduct handling practices. During the RI, arsenic was detected at a maximum concentration of 0.057 mg/l at Batiste Spring, while most of the samples contained arsenic below 0.025 mg/l, within the range of representative concentrations. The maximum arsenic concentration at Old Pilot House well during the RI was 0.050 mg/l; the minimum value was 0.037 mg/l.

Data Presentation Conventions

Several methods have been used in reporting the characteristics of analytical results in this section. These are as follows:

- Representative groundwater concentrations have been identified by the mean concentration plus or minus two standard deviations of each constituent among the 16 representative wells. This corresponds approximately to the 95th percentile of the arithmetic mean. This approach was also used to describe representative surface and subsurface soils, and is consistent with EPA Region 10 policy.
- For each representative well, the mean concentration of each constituent was calculated using only analytical results that were not flagged with a "U" (nondetect) qualifier during data validation. For example, if the results of two out of 10 sampling events were reported with a U qualifier, only eight data points were used to calculate the mean; the nondetect samples were not replaced with zeros or one-half the detection level. This approach provides a better description of the concentrations of constituents present in representative groundwater than would the inclusion of sporadic nondetect values.
- It was sometimes necessary to compare the mean concentration of a constituent detected in samples collected from a single well with the analytical detection limits for that constituent. In these cases, a characteristic detection limit was calculated for each constituent that was not detected in one or more samples. To do this, the results with the U qualifier for each of these constituents for samples collected from Wells 101 and 102 were averaged to identify the mean sample detection limit for each constituent. Wells 101 and 102 were used because they are representative wells.

This method was chosen over the method in which the detection limit is divided by two (EPA, 1989) because of a lack of consistency in reported sample detection limits. The instrument detection limit (IDL) for inorganic parameters cited in the EMF/RI/FS Sampling and Analysis Plan (Bechtel, 1992b) was not always achieved or was not appropriate due to a variety of field-, laboratory-, and blank-related issues. Consequently, reported sample detection limits (i.e., values at which a U qualifier was assigned) for one or more parameters for a given sample during a given sampling round were often well above the IDL and, in many instances, were above unqualified analytical results for the same parameter in previous or subsequent rounds of sampling.

4.4.1 Representative Groundwater Chemistry

The representative groundwater chemistry must be well defined prior to assessing the nature and delineating the extent of site impacts. Typically, wells upgradient from a potential source area are sufficient to describe the representative groundwater chemistry. In the EMF study area, there are several distinct natural hydrogeologic areas and associated water chemistries, as well as a number of potential sources. This complicates the definition of representative groundwater chemistry because there are mixing zones where these hydrogeologic areas and water chemistries meet. Thus, several distinct hydrogeochemical regimes may be upgradient from a given potential source. In addition, several potential sources may lie along a groundwater flowpath, resulting in one source being upgradient of another. Thus, an assessment of the potential impact of a release from the more-downgradient source cannot be made until the potential impact of the more-upgradient source is identified.

Because there are other anthropogenic activities that impact groundwater quality in the EMF study area (e.g., the presence of a National Priorities List [NPL] site upgradient from the EMF facilities along the Portneuf River Valley), the term "background" is not used to describe groundwater chemistry unimpacted by EMF site-related activities. Rather, the term "representative" is used to describe constituent concentrations that reflect non-EMF site-related groundwater quality but that may reflect constituent levels contributed by offsite sources.

4.4.1.1 Selection of 16 Representative Wells

In light of the presence of three hydrogeologic areas, various offsite groundwater impacts, and other factors, the following criteria were used to select representative wells:

- The group of wells must be representative of the three different hydrogeologic areas delineated in Section 3.3.

- The well group must represent groundwater from the different lithologies described in Section 3.1.
- The wells must be located upgradient or crossgradient from known or suspected EMF source areas, as defined by horizontal and/or vertical hydraulic gradients.
- Inorganic geochemistry must be consistent for wells within the group; if significant outliers exist, there must be a plausible explanation for these outliers that relates them to known non-EMF sources and activities.

On the basis of these criteria, an initial set of 16 wells was selected (Figure 4.4-7). These wells comprise a representative cross-section of the different geologic and hydrogeologic conditions that exist in the EMF study area. Although there are other wells in the study area that are not impacted by site-specific activities, they were not used to define representative concentrations in the early part of the analysis because it was not clear at that time that they were upgradient (or crossgradient) of potential sources. It was only after results from wells sampled during Phase II of the RI were available that it could be shown that these wells were clearly upgradient.

The initial set of 16 wells and associated hydrogeochemical regimes are:

- Michaud Flats: Wells 101, 102, TW-10S, 147
- Bannock Range: Wells 130, 120, 106, Idaho Power, 301, PEI-1, 305
- Portneuf River Valley: Wells PEI-6, 510, 511, 512, 513

When evaluating representative concentrations of certain constituents in groundwater, it is also important to have a time series of data to define the representative values. Time-series data provide a better estimate of concentrations because seasonal and long-term trends can be evaluated. In addition, the overall variability of the groundwater chemistry is depicted better by long-term monitoring. Several wells in the group have 10 or more data points over a period of 3 years. The 500- and 300-series wells were installed in 1992 and have four data points associated with them.

Time-series data of groundwater elevations are also important when defining wells that are upgradient and crossgradient from a potential source. In Section 3.3, the overall consistency of the groundwater gradients, both vertical and horizontal, was demonstrated. This consistency is critical for increasing the certainty of defining hydraulic relationships between wells and potential sources.

As shown in Figure 4.4-7, Wells 120, 130, 301, PEI-1, and 305 are close to existing or former waste management facilities. Because these wells are close to potential sources, the chemical and physical groundwater parameters of these wells were compared to other representative wells in the same hydrogeologic area. The

comparison confirmed that these wells were unaffected by facility activities, and Wells 120, 130, 301, PEI-1, and 305 were retained in the representative well network.

Wells 301 and PEI-1 were included because groundwater elevations in these wells indicated there was a significant interval (60 feet) of unsaturated soil and bedrock between any gypsum stack water and the groundwater in these wells. In addition, the water in these wells is hydraulically upgradient from wells along the north of the gypsum stack, further indicating that these wells are truly upgradient from the gypsum stack.

Well 130 is screened in the deeper saturated unit and is separated from the upper saturated gravels by a silt aquitard that is approximately 46 feet thick. Well construction details indicate the solid casing penetrates former Pond 6E. There is a well seal consisting of bentonite-cement grout and a bentonite seal above the filter pack. These seals should prevent vertical migration of constituents downward, into Well 130. The vertical head differences between Well 130 and the nearby shallow Wells 129 and 137 indicate vertical hydraulic gradients are very low. The direction of vertical gradient is variable; during some periods, downward vertical gradients are observed and at other times, upward vertical gradients are measured (Figures 3.3-5A to 3.3-5E). Overall, the vertical separation between the upper saturated gravel and the deeper gravel monitored by Well 130 indicates that groundwater quality in Well 130 should not be impacted by past or current facility activities.

Well 130 was selected at the beginning of the RI because there was a long groundwater sampling record for this well. In Phase II, Well 158 was installed further upgradient from the former ponds area. Water levels in Well 158 are 2 to 3 feet higher than water levels in Well 130 (Figure 3.3-3E). Water chemistry results from Well 158 are similar to those from Well 130. However, Well 158 was not substituted for Well 130 as a representative well because it had only been sampled once before preparation of this report.

Well 120 is located crossgradient from Pond 8S, about 140 feet from the northeastern edge of the pond. Well 120 is screened in the upper saturated gravel unit. This portion of the aquifer has been impacted by releases from Pond 8S, as evidenced by analytical results for samples from Wells 150 and 152. The water chemistry from Well 120 is markedly different from that of these two wells, showing much lower concentrations of metals, major ions, and other parameters. These lower concentrations reflect unimpacted representative groundwater flowing through this area. Well 158 is located upgradient from Well 120 and exhibits similar water chemistry, with only subtle differences.

In conclusion, Wells 120 and 130 are located very near known areas of impacted groundwater but contain lower metal, nutrient, and major ion concentrations than wells immediately downgradient from these areas. Concentrations of all parameters measured in Wells 120 and 130 are similar to concentrations detected in other

representative wells. On the basis of this information, the groundwater analytical data from these wells were used to define representative groundwater chemistry. When additional groundwater data become available for Well 158, this well may replace Wells 120 and 130, or Well 158 may be added to the representative groundwater database. Wells 514, 515, and 516 (which were also installed during Phase II) may also be added to the network of representative groundwater wells after additional sampling results become available.

Well 305 is crossgradient from the gypsum stack and lies on the east side of a draw within the Bannock Range area. The groundwater from Well 305 is representative of deeper Bannock Range groundwater, unaffected by gypsum stack activities.

4.4.1.2 Characteristics of Representative Groundwater Quality

Major Ions. In the evaluation of the major ion chemistry, three hydrogeochemical regimes have been defined within the shallow saturated zone. These are:

- Michaud Flats groundwater, which has a calcium-chloride water chemistry; higher concentrations of all common ions, except bicarbonate, than Bannock Range groundwater; and higher concentrations of calcium, chloride, potassium, and sodium than Portneuf River groundwater.
- Bannock Range groundwater, which has a calcium-bicarbonate water chemistry with lower overall ionic concentrations than the other two regimes.
- Portneuf River Valley groundwater, which has a calcium-bicarbonate water chemistry with a higher proportion of bicarbonate ion than the other two regimes.

The areas of these three regimes are plotted in Figure 3.3-1. This figure also illustrates the hydrogeologic areas defined previously in Section 3.3. "Hydrogeologic areas" are defined by geologic and hydrogeologic physical properties such as hydraulic conductivity; "hydrogeochemical regimes" are defined by general water chemistry parameters.

Groundwater in the Bannock Range hydrogeochemical regime can be separated into high- and low-chloride subgroups. For the low-chloride Bannock Range subgroup, concentrations of most common ions are lower than those for the other two hydrogeochemical regimes. High-chloride Bannock Range water chemistry may represent mixing of Michaud Flats and low-chloride Bannock Range groundwater. Concentrations of common ions are generally higher in the high-chloride Bannock Range water than in the low-chloride Bannock Range water (Table 4.4-1).

For Portneuf River groundwater, the concentrations of common ions are less variable than in the other two hydrogeochemical regimes. Calcium and sodium

concentrations are similar to those found in Michaud Flats and Bannock Range groundwater. Chloride and potassium concentrations tend to be low, and magnesium and sulfate concentrations tend to be greater than those found in the Michaud Flats and Bannock Range regimes (Table 4.4-1).

The mean concentrations of common ions from the 16 representative wells (Table 4.4-1) were used to prepare Piper and Stiff diagrams of common ion proportions. With these diagrams, characteristic common ion balance (or common ion water chemistry) of the three hydrogeochemical regimes can be distinguished.

Piper diagrams (Figure 4.4-8) present cation/anion ratios in percent milliequivalents per liter (mEq/l). In the Piper diagram, the two triangles present cation (calcium, magnesium, and sodium plus potassium) and anion (bicarbonate plus carbonate, sulfate, and chloride) ratios.

All three regimes cluster tightly in the cation triangle, showing the similarity in cation ratios among the three hydrogeochemical regimes. The clear separation of the Michaud Flats water from the other two regimes in the anion triangle demonstrates the calcium-chloride chemistry of this hydrogeochemical regime compared with the calcium-bicarbonate chemistry of the Bannock Range and Portneuf River hydrogeochemical regimes. In the quadrilateral portion of the Piper diagram, the clustering of points into three groups demonstrates the overall water chemistry similarity within each regime.

Figure 4.4-9 presents Stiff diagrams for the Michaud Flats, Bannock Range, and Portneuf hydrogeochemical regimes. The Stiff diagrams for all three regimes show calcium is the dominant cation. Chloride is the dominant anion in Michaud Flats groundwater.

Michaud Flats representative Wells TW-10S and 147 have higher concentrations of sodium, potassium, and chloride than representative wells to the east and south (e.g., Wells 101 and 102). Goldstein (1981) examined springs and wells in the Pocatello and Michaud Flats area. Data reported for the Crockett well, located approximately 2.5 miles (4 km) north and west of the EMF facilities, had even greater concentrations of salts than Wells 147 and TW-10S (Goldstein, 1981). This suggests that salinity (sodium, potassium, and chloride) increases toward the west and north in Michaud Flats groundwater.

As a criterion to compare representative concentrations with impacted groundwater concentrations of common ions, mean concentrations and standard deviations were calculated using the entire data set for the 16 representative wells (Table 4.4-1). A range for representative concentrations was then calculated for each ion based on the mean plus or minus two times the standard deviation (2XSD).

Physical Parameters. Previous investigations within the EMF study area have included characterization of physical parameters as a means of identifying sources of water. Data were collected and analyzed for samples from all wells in the RI program for the following parameters:

- pH
- Specific conductance
- Temperature
- Total dissolved solids
- Reduction/oxidation potential (redox)

The means and ranges of the physical parameters for the 16 representative wells are presented in Table 4.4-1. Means and ranges were also calculated for the entire data set and for each of the three hydrogeochemical regimes.

Groundwater was generally neutral to slightly alkaline (pH range from 6.9 to 8.9). Evaluation of the time series of pH values obtained from Well PEI-1, which had the highest pH value (9.4), indicates that this value is an outlier. Other physical parameters show more variability among the three hydrogeochemical regimes.

Michaud Flats groundwater had a higher range of specific conductance (621 to 1,059 $\mu\text{mhos/cm}$) and total dissolved solids (209 to 876 mg/l) and generally low mean temperature compared with the other regimes (14.2°C). It had both positive and negative redox values (-38 to 156 mV). Higher specific conductance and total dissolved solids values were consistent with the overall higher ionic concentrations for groundwater in the Michaud Flats.

Reduction/oxidation potential (redox) is the ability of the groundwater to bring about oxidation or reduction; it is commonly given the symbol Eh (in mV). Redox was measured only during one sampling round (March 1993); Eh ranged from -38 to 255 during this sampling event among the 16 representative wells. Well TW-10S, which was constructed with a mild steel casing, was the only well with a negative redox value.

Low-chloride Bannock Range groundwater was characterized by low specific conductance (286 to 708 $\mu\text{mhos/cm}$) and total dissolved solids (163 to 468 mg/l), higher temperatures (16.1°C), and a wide range of positive redox values (41 to 104). High-chloride Bannock Range groundwater was characterized by specific conductance and total dissolved solids intermediate between Michaud Flats and low-chloride Bannock Range groundwaters.

The Portneuf River regime was characterized by intermediate specific conductance (611 to 933 $\mu\text{mhos/cm}$) and total dissolved solids (394 to 591 mg/l), lower

temperatures (13.2°C), and a narrower range of positive redox values (83 to 137) than the other regimes.

Nutrients and Fluoride. Data have been collected and analyzed for samples from representative wells in the RI program for the following parameters (Table 4.4-2):

- Ammonia
- Nitrate
- Orthophosphate
- Total phosphorus
- Fluoride

The nutrients and fluoride occur naturally to some degree in groundwaters but are also contributed by numerous anthropogenic activities such as septic systems, livestock raising, fertilizer application, and other activities. In addition, certain soil and rock types may leach phosphorus, present as a naturally occurring element in the minerals. These constituents were also identified in the EMF feedstock, byproduct, and wastestreams.

Ammonia (NH₃ as N) concentrations were negligible in the representative wells. The mean concentration of ammonia ranged from nondetect (ND) to 0.8 mg/l. Maximum concentrations were: fluoride, 0.8 mg/l; nitrate, 4.8 mg/l; orthophosphate, 2.7 mg/l; and total phosphorus, 3.2 mg/l. Wells 130 and 120 had the highest orthophosphate and total phosphorus concentrations. The Michaud Flats regime generally had higher nutrient concentrations than the other two hydrogeochemical regimes; the Portneuf River regime generally had lower nutrient concentrations, with the exception of nitrate. The mean concentration of nitrate in the Portneuf River regime was 2.6 mg/l, and the mean plus or minus two standard deviations ranged from 0.9 to 4.3 mg/l (Table 4.4-2).

For some parameters (e.g., ammonia) there were no samples with an analytical result reported above the detection limit for any round of sampling conducted for some wells. Table 4.4-2 documents this information by reporting NH (no hits) rather than ND, the mean sample detection limit.

Metals. Representative groundwater was analyzed for 22 alkali metals, alkaline earths, and trace metals (hereafter referred to as metals) (Table 4.4-3). The results are discussed in this section.

Most metals (16 of 22) were not detected in representative groundwater or were detected in only a few samples, or from a few wells and in low concentrations. Mean concentrations were below detection or negligible (detected in only a few wells or a few samples at levels very close to the detection limit) in all three

hydrogeochemical regimes for antimony, beryllium, cadmium, manganese, mercury, molybdenum, nickel, selenium, silver, and thallium. Mean representative concentrations were low in all three hydrogeochemical regimes for aluminum (0.18 mg/l), chromium (0.005 mg/l), cobalt (0.018 mg/l), lead (0.002 mg/l), lithium (0.031 mg/l), mercury (0.0006 mg/l), and vanadium (0.024 mg/l).

Arsenic, barium, and boron were found consistently in representative groundwater for all three hydrogeochemical regimes. Arsenic was detected in representative groundwater at mean concentrations from 0.004 to 0.032 mg/l. Barium was found in representative groundwater at mean concentrations from 0.04 to 0.23 mg/l. Boron was found in representative groundwater at mean concentrations from 0.04 to 0.26 mg/l.

The presence of iron, copper, and zinc in representative groundwater was not consistent over time or among the three regimes. Iron was found in representative groundwater at mean concentrations from below the detection limit to 2.00 mg/l. Measurements over 1.0 mg/l were generally limited to initial rounds of sampling for wells such as 512, 101, and 102. In the case of Wells 512 and 101, iron was not detected in subsequent rounds of sampling after initial measurements of 2.00 and 1.98 mg/l, respectively.

Copper and zinc were found generally only in the Bannock Range regime. Copper was detected at mean concentrations up to 0.014 mg/l. Mean zinc concentrations were either below the mean detection limit (0.017 mg/l) or at much higher concentrations (0.269 to 0.287 mg/l). These two higher readings were detected at Idaho Power and PEI-1. The average for PEI-1 may be an artifact attributable to one very high outlier (0.72 mg/l), one nondetect, and two samples under 0.1 mg/l (0.07 and 0.018 mg/l). Hence zinc concentrations were probably not as high as these values would indicate (Table 4.4-3).

Radiological Parameters. A summary of the activities for radiological parameters—gross alpha, gross beta, radium-226, and radium-228—for the 16 representative wells is presented in Table 4.4-4. Activities are presented in picocuries per liter (pCi/l). Due to the variability inherent in the analytical method used for radiological parameters, a detailed statistical analysis was not conducted.

Representative gross alpha activities in the Michaud Flats regime ranged from ND to 7.34 ± 2.38 pCi/l. Gross alpha activities for the Bannock Range groundwater ranged from ND to 4.94 ± 1.06 pCi/l for Well 301 in March 1993. Gross alpha activities for representative wells in the Portneuf River regime ranged from ND to 4.6 ± 2.3 pCi/l for Well PEI-6 in June 1992.

The representative range for all three regimes was ND to 7.34 ± 2.38 pCi/l. Gross alpha activities were detected more consistently and at slightly higher levels in the

Michaud Flats regime and were detected less frequently and at slightly lower levels in the Portneuf River regime.

Gross beta activities in representative groundwater in the three hydrogeochemical regimes ranged from ND to 45.8 ± 2.65 pCi/l. The gross beta activities were comparatively higher in the Michaud Flats regime, intermediate in the Bannock Range regime, and lowest in the Portneuf River regime.

Gross beta activities for the Michaud Flats regime ranged from 4.1 ± 2.9 pCi/l to 45.8 ± 2.65 pCi/l (Table 4.4-4). Gross beta activities for the Bannock Range regime ranged from ND to 30 ± 5.12 pCi/l. Gross beta activities for the Portneuf River regime ranged from ND to 9.3 ± 0.88 pCi/l (Table 4.4-4).

Radium-226 was not detected in 11 of the 16 representative wells. In the remaining five wells, radium-226 was detected during only one sampling event. In Wells TW-10S and 147 in the Michaud Flats, and Wells 120, 301, and 305 in the Bannock Range, activities ranged from 1.55 ± 0.42 to 6.35 ± 0.57 pCi/l.

Radium-228 was not detected in 5 of the 16 representative wells. For nine of the remaining 11 representative wells, radium-228 was detected during only one sampling event. For these nine wells, activities ranged from 1.00 ± 0.80 to 7.20 ± 1.00 pCi/l. Radium-228 was detected during two sampling events for Well 102 and for three sampling events for Well 301. Activity ranges for these two wells were 1.8 ± 0.9 to 6.5 ± 1.2 pCi/l and 1 ± 0.6 to 2.7 ± 1 pCi/l, respectively (Table 4.4-4).

Organic Compounds. Samples were analyzed for volatile and semivolatile organic compounds from selected wells during the RI program. Analyses for organic compounds were first conducted during the September 1992 round of sampling. The results from the 16 representative wells are presented in this section.

Actual values for organic compounds detected in representative wells are presented in Table 4.4-5. Analyses were performed for samples from 9 of the 16 representative wells. Organic compounds were detected sporadically in these representative wells.

Of the 11 volatile or semivolatile organic compounds reported in representative well samples, most or all may not have been present in groundwater. Several compounds are common laboratory contaminants, including methylene chloride, acetone, and plasticizers (phthalates). Compounds reported infrequently and at low concentrations, such as 2-butanone, may represent an aberration in the analytical methodology and may not actually have been present in the sample.

One compound, tetrachloroethene, was detected during all three rounds of sampling at Well 511, but was not detected in any other representative well. Tetrachloroethene was encountered at low concentrations (0.001 to 0.003 mg/l) in this well. The presence of this compound most likely represents a source in or

along the Portneuf River above the EMF facilities. Studies at an NPL site upstream (and upgradient) of the EMF facilities have documented the presence of chlorinated solvents in the groundwater.

4.4.1.3 Method for Defining Groundwater Impacted by EMF-Related Constituents

After the mean values and variability were defined for each constituent and parameter in representative groundwater, a method was established to use this information to characterize the nature and extent of EMF-related constituents in groundwater.

One of the first things noticed when inspecting groundwater chemistry from other wells at the EMF facilities was the marked increase in common ion concentrations observed in wells immediately downgradient from former ponds and the gypsum stacks. On the basis of these observations, common ion chemistry for all wells was compared to the representative common ion chemistry. This comparison yielded a number of wells associated with known or suspected sources that were classified as having been impacted by EMF-related activities.

Metal concentrations were also compared with representative groundwater concentrations. This comparison found that most or all wells with common ion concentrations within the ranges defined by representative groundwater did not have elevated metal concentrations relative to representative ranges. For the most part, these comparisons were used to develop a well classification of "impacted" versus "unimpacted." Impacted refers to a well that contains groundwater with chemistry outside the representative ranges and that appears to reflect an EMF-related source. Unimpacted refers to a well that contains common ion and metal concentrations within the representative ranges.

In many cases, the comparison of common ion concentrations was not sufficient to classify a well and a final comparison using metal and nutrient concentrations was needed before deciding if samples collected from a well exhibited impact by EMF-related activities.

The wells characterized as impacted or unimpacted by EMF facility activities are identified in each of the following sections. The ranges of constituents detected in unimpacted and impacted wells for the EMF study are presented in Tables 4.4-6 and 4.4-7.

As with all classification schemes, there are exceptions. The primary cause for this is the criterion that all representative wells within a given hydrogeologic area have similar chemistry. This criterion artificially reduced the degree of variability used to characterize representative groundwater chemistry. For instance, there is evidence that Michaud Flats groundwater has highly variable common ion concentrations.

These exceptions are also noted in the following sections. A detailed discussion of constituents detected in unimpacted groundwater beyond the range found in the 16 representative wells is provided in Appendix M.

4.4.2 Characterization of Groundwater Quality at FMC

The nature and extent of site-related constituents beneath the FMC facility focuses on the southwestern and central areas of the facility (Figures 4.4-6, 4.4-10, and 4.4-11). Groundwater in the easternmost portion of the FMC facility, near the FMC-Simplot joint fenceline area, may be influenced by commingling of impacted groundwater from multiple potential sources. The eastern FMC area is included in the discussion of the joint fenceline area in Section 4.4.4.

This section begins with a brief overview of findings, continues with a detailed discussion of the nature of site-related constituents, and concludes with a description of the extent of these constituents beneath the southwestern and central areas of the FMC facility.

4.4.2.1 Overview of Findings

Southwestern FMC Area. The groundwater beneath the former ponds begins its flowpath in either the Bannock Range area or the Michaud Flats, and converges in an area immediately northwest of the former ponds (Figure 4.4-10).

It appears that residual levels of constituents in silts beneath the former ponds in the southwestern FMC area contributed detectable concentrations of 17 parameters to groundwater; constituents from Pond 8S (which still had a sustained hydraulic head during the investigation) were also present in the groundwater. The constituents are ammonia, arsenic, boron, calcium, chloride, cobalt, fluoride, lithium, magnesium, nitrate, orthophosphate, potassium, selenium, sodium, sulfate, gross alpha, and gross beta. Most of these parameters were found in enriched concentrations in the process water held in the former unlined ponds. The primary constituents of potential concern appear to be arsenic, chloride, fluoride, nitrate, selenium, sodium, and sulfate.

As groundwater flows through the former ponds area, concentrations of many of the above-mentioned 17 constituents increase. Wells immediately downgradient of Pond 8S, the only unlined pond still containing water at the time of the investigation (Pond 8S was being closed in the fall of 1993), contained the highest concentrations of most constituents emanating from the former ponds. Wells located immediately downgradient of former ponds no longer containing a hydraulic head had lower concentrations of these constituents. Where there was no hydraulic head in the former ponds, the constituents may have been released from the silts in the saturated zone underlying the former ponds (Figures 4.2.3-4 through

4.2.3-7). The silts in the saturated zone beneath the ponds may have adsorbed previously released constituents and may have been undergoing a reversible desorption process at the time of sampling. At Pond 8S, the higher concentrations of site-related constituents may have been related to direct infiltration of water contained in the pond. This pattern indicates that the removal of a sustained hydraulic head from former ponds results in improved groundwater quality.

Although the water contained in Pond 8S is not process water, the infiltration or percolation of this water through the sludge within the pond may have provided a mechanism that increased the flux of these constituents into the shallow groundwater. After the infiltrating water is cut off when the pond is closed, the concentrations of Pond 8S-related constituents are expected to decrease in downgradient wells. Closure of Pond 8S began in the fall of 1993.

Vertical hydraulic gradients were measured between the uppermost saturated gravels and deeper gravels in several well pairs throughout the southwest and central FMC area (Figures 3.3-5A through 3.3-5E). In the area of the former ponds, and throughout most of the FMC facilities, there are strong upward (positive) vertical gradients. These positive vertical gradients prevent downward migration of constituents that infiltrate to the upper saturated gravels.

As groundwater flows beyond the pond area, concentrations of site-related constituents decrease. Groundwater continues flowing to the central FMC area.

Central FMC Area. Concentrations of pond-related constituents decreased through the mixing zone associated with the convergence of Bannock Range and Michaud Flats groundwater (Figures 4.4-10 and 4.4-11), until the groundwater flowed beneath former Ponds 1S, 2S, 3S, 0S, and 00S, located in the central FMC area (Figure 4.4-11). In addition, the slag pit and railroad swale may also have contributed constituents to the groundwater flowing through this area. The former ponds in the central FMC area do not contain water, and the release of constituents from these sources was probably similar to the other former ponds to the southwest. The railroad swale may have contributed minor amounts of constituents to the groundwater. A continuous release is not expected to be observed at the railroad swale since this depression contains primarily solid particulates associated with FMC operations.

Ammonia, arsenic, boron, chloride, lithium, nitrate, orthophosphate, potassium, selenium, sodium, and sulfate concentrations, and gross alpha and gross beta activities increased as groundwater flowed through the central FMC area. In general, these increases were not as pronounced as those detected in the upgradient former ponds area. The primary constituents of potential concern appear to be arsenic, chloride, nitrate, selenium, sodium, and sulfate.

Unimpacted groundwater flowing through the central FMC area originated upgradient from the slag piles. After flowing directly beneath the slag piles, this

groundwater did not contain any site-related constituents above representative concentrations. As this groundwater subsequently flowed through the central FMC area, the above-mentioned constituents were detected at slightly elevated concentrations, indicating the presence of sources in the central FMC area.

As was observed in the former ponds area, concentrations of the site-related constituents decreased rapidly with increasing distance from sources, indicating rapid attenuation.

A large proportion of the groundwater flowing through the central FMC area was ultimately captured by the Simplot production wells. Some portion of the impacted groundwater did not appear to be captured, but rather appeared to continue along an eastward flowpath extending to the northern FMC fenceline and beyond near Well 111.

The flowpath captured by the Simplot production wells can be delineated by Wells 107, 146, and 517, all of which contain groundwater with elevated temperatures associated with heating of the soils beneath the FMC slag pit.

4.4.2.2 Identification of Site-Related Constituents in FMC Groundwater

The analytical results obtained from groundwater samples collected during the RI were evaluated to identify:

- Constituents that could be eliminated from further consideration either because they were not present at levels that exceeded representative concentrations, or because they were detected sporadically at concentrations very close to the detection level
- Constituents that are site related or that assist in characterizing releases from source areas within FMC

This process served to simplify the identification and description of the nature and extent of site constituents present in groundwater associated with source areas within FMC.

Constituents That Were Eliminated. The representative concentrations for constituents in groundwater, described in Section 4.4.1, were compared with analytical results from wells at FMC that were not part of the representative network. This comparison identified constituents that were either not detected or present at concentrations at or below representative concentrations in groundwater beneath the FMC facility. The results of this comparison, presented in Table 4.4-8, indicate that most organic compounds and the metals antimony, lead, molybdenum, silver, barium, mercury, beryllium, thallium, and zinc were either

not present or were present below representative concentrations in FMC groundwater.

Cadmium, chromium, and nickel were detected sporadically at concentrations just above detection levels or sporadically at concentrations just above representative concentrations (Table 4.4-8). These constituents are believed to be naturally present in groundwater. Their presence at concentrations just above the upper limit of representative concentrations is likely due to natural variability in groundwater quality that was not fully reflected in samples from the representative wells.

Aluminum and iron were also detected sporadically, but at concentrations above their representative concentrations. Their presence is believed to be due to silt accumulation in three monitoring wells (116, 131, and 123). These parameters are not believed to be associated with releases from source areas. Aluminum and iron are major components of natural silts.

Manganese was also detected in wells at above-representative concentrations (Figure 4.4-12). However, the presence of manganese is not believed to be site related. These concentrations are likely associated with naturally occurring manganese oxide. The geologic drilling logs for these wells indicate the presence of a black manganese or iron oxide in the saturated zone. Also, the logs for Wells 308 and 136 indicate the presence of black fine-grained sediment and black gravel; this likely indicates the presence of natural manganese oxide.

It was concluded that the 15 metal constituents identified in Table 4.4-8, plus most volatile and semivolatile organic compounds, are not site-related constituents in groundwater beneath the FMC facility. These constituents were therefore eliminated from further consideration.

During the evaluation, a zone of groundwater was identified beneath FMC that contained concentrations of sodium, barium, lithium, chloride, nitrate, and boron that were greater than those present in representative wells. This area extends to the west and north from Wells 128 and 139 through the Lindley well and Well 515, both of which are beyond the FMC boundary, and to representative Wells 147 and TW-10S on the west. Several wells east of this area exhibited lower concentrations of the same constituents, although these levels still exceeded the representative concentrations.

A detailed evaluation indicates that the elevated concentrations in these wells are not attributable to releases from FMC sources. This evaluation, presented in Appendix M, suggests that a natural salt pan may have once been present in this area after deposition of the Michaud Gravel, and that leaching of these residual salts contributes these constituents. Boring logs from this area identify a caliche-type paleosol, described as containing carbonate nodules in a clay matrix, indicative of evaporite deposition.

Identification of Site-Related Constituents. The results of groundwater samples from 60 monitoring wells were compared with the potential source characterization to assess which constituents found in groundwater were attributable to site-related releases.

The potential source areas addressed were:

- Former Ponds 1E through 6E, 1S through 3S, 5S through 9S, including unlined Pond 8S, which was operational during 1992 and most of 1993, in the southwestern area
- The slag pit adjacent to the furnace building and the railroad swale at the northern facility boundary

Four metals were detected above representative concentrations in groundwater beneath the potential source areas listed above (see Table 4.4-9). These were arsenic, boron, lithium, and selenium. In addition to these, cobalt was present at above-representative concentrations in the former ponds area, and copper was detected in a limited number of wells. Thirty-three impacted wells were identified through comparison of common ion concentrations with concentrations at representative wells.

Arsenic was detected in 23 wells with elevated common ion concentrations. These wells are located in the southwestern area through the central area, and near the northern fenceline. Arsenic (total) concentrations ranged from 0.008 to 0.252 mg/l. These wells include shallow Wells 104, 114, 115, 132, 134, 141, 150, and 152 (0.047 to 0.252 mg/l), and deeper Wells 131 and 103 (0.017 to 0.059 mg/l) monitoring Bannock Range groundwater; Wells 111, 112, 135, and 137 (0.043 to 0.118 mg/l) monitoring Michaud Flats groundwater; and Well 116 (0.022 to 0.113 mg/l). Arsenic concentrations for deeper Well 103 (0.033 to 0.036 mg/l) were within the upper range of concentrations found in representative wells (0.032 mg/l).

Figure 4.4-13 shows the wells where arsenic was detected in groundwater beneath all areas of the FMC facility. In addition to its distribution across the facility, arsenic was also a common constituent within each potential source area.

Arsenic was detected in impacted Wells 108, 146, and 121 in the FMC slag pit area. Arsenic concentrations for these wells ranged from 0.008 to 0.043 mg/l (Table 4.4-9). Well 108 had arsenic concentrations (0.028 to 0.043 mg/l) just above the upper representative limit (0.032 mg/l). Shallow Well 121 had levels of arsenic (0.009 to 0.022 mg/l) within the range for representative wells.

Selection of Nutrients and Fluoride as Site-Related Constituents. Characterization of nutrients and fluoride in groundwater at FMC was used to identify release sources and to describe the nature and extent of site-related parameters. Analytical results from the FMC monitoring wells and comparison with data on the

composition of feedstocks, byproducts, and wastes indicated that the following nutrients may be used as characteristic constituents:

- Ammonia
- Nitrate
- Orthophosphate
- Total phosphorus

Fluoride was also used as a characteristic constituent. Analytical results collected during the RI sampling program (June 1992 through May 1993) for nutrients and fluoride for the 33 wells with elevated common ion concentrations are presented in Table 4.4-10.

Ammonia (NH_3 as N) was present at a mean concentration of 3.4 mg/l in wells in the immediate vicinity of Pond 8S; its concentration ranged from 0.3 to 11 mg/l. Ammonia was not detected in samples from wells associated with the slag pit area. The upper limit of ammonia in representative wells was 0.8 mg/l.

Nitrate (NO_3 as N) was present at a mean concentration of 7.7 mg/l in wells associated with the former ponds area, with a range in concentration from 0.1 to 32 mg/l. However, nitrate was not found in wells immediately downgradient of Pond 8S, but it was detected at a mean concentration of 15 mg/l in wells associated with the slag pit. The upper limit of nitrate in representative wells was 4.5 mg/l.

The two phosphate parameters were detected in nearly all samples from wells in the former ponds area. The mean concentration of orthophosphate (PO_4 as P) was 40 mg/l, with a minimum detected value of 0.03 mg/l and maximum of 428 mg/l. The upper limit of orthophosphate in representative wells was 1.8 mg/l. Total phosphorus was detected at a mean concentration of 75 mg/l in the former ponds area, with a range in concentrations from 0.02 to 679 mg/l.

Neither orthophosphate nor total phosphorus was detected at concentrations exceeding representative concentrations in wells associated with the slag pit.

Fluoride was detected at above-representative concentrations in both the former ponds and slag pit. The mean concentration in the former ponds area was 1.9 mg/l, with a detected range from 0.1 to 11 mg/l. In the slag pit area, the mean was 1.7 mg/l; the minimum concentration was 0.7 mg/l and the maximum was 4.5 mg/l. The upper limit of fluoride in representative wells was 0.7 mg/l.

Selection of Common Ions as Site-Related Constituents or Indicators. Table 4.4-11 presents a summary of common ion concentrations and physical parameter measurements in the FMC monitoring wells with impacted water chemistry. Some of these common ions and physical parameters can also be used to characterize potential sources.

Impacted wells in the former ponds area of the FMC facility had mean common ion concentrations above the upper representative limit for all common ions. These wells also had higher specific conductance and TDS.

For the former ponds area, the common ion with the greatest increase over the upper limit of representative concentrations was potassium. The maximum potassium concentration was 1,400 mg/l, compared to the representative concentration of 13 mg/l. Other constituents were also present above representative concentrations in the former ponds area. Calcium was present at a mean concentration of 100 mg/l; while this was less than the upper representative concentration (105 mg/l), the maximum concentration of 294 mg/l exceeded the representative upper limit. Chloride was present at a mean concentration of 232 mg/l, and ranged from 50 to 644 mg/l; the upper representative concentration was 177 mg/l. Magnesium was present at concentrations (up to 119 mg/l) above the representative concentration upper limit (42 mg/l); its mean concentration (55.4 mg/l) was close to the representative concentration. The mean concentrations of both sodium (247 mg/l) and sulfate (196 mg/l) exceeded the upper representative concentrations (64 mg/l and 79 mg/l, respectively). For wells with impacted water chemistry in the slag pit area, mean concentrations for potassium (139 mg/l), sodium (105 mg/l), and sulfate (211 mg/l), plus specific conductance (1,679 μ mhos/cm), temperature (23.8°C), and TDS (1,086 mg/l), were greater than the upper representative concentrations (Table 4.4-11).

Selection of Radiological Parameters as Site-Related Indicators. Wells 150 and 152 in the former ponds area had elevated gross alpha activities for at least one sampling event (Table 4.4-12). Eight wells monitoring the former ponds area had consistently elevated gross beta activities: 150, 152, 104, 132, 111, 134, TW-5S, and 116. Gross beta occurred above the upper range of representative activities of 45.8 pCi/l in Well 111 (maximum of 108.1 pCi/l), Well TW-5S (maximum of 174 pCi/l), Well 104 (maximum of 384 pCi/l), Well 132 (maximum of 240 pCi/l), Well 134 (maximum of 181 pCi/l), Well 150 (maximum of 1,110 pCi/l), Well 152 (maximum of 355.2 pCi/l), and Well 116 (maximum of 300 pCi/l).

In the central area, gross beta exceeded representative activities in Well 121 (99.8 pCi/l), Well 122 (maximum of 171 pCi/l), Well 108 (186 pCi/l), and Well 146 (66.4 pCi/l) (Table 4.4-12). As in wells near the former ponds, potassium concentrations were also elevated in these wells (Table 4.4-11).

Selection of Other Constituents. Several VOCs were found in wells monitoring the slag pit area in the central area. As shown in Table 4.4-13, trichloroethene (TCE) was detected during three rounds of sampling at Well 121 at concentrations from 0.008 to 0.015 mg/l. TCE was also detected in Wells 108 and 146, downgradient from Well 121, at concentrations of 0.002 to 0.003 mg/l. TCE was not detected in wells located upgradient from the central area or in the northern portion of the central

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area. These data suggest that TCE was present in groundwater in a limited area of impact extending from Well 121 to Wells 108 and 146.

Summary. Review of this information indicates that arsenic is a key site-related constituent for a number of potential sources. Gross beta can also be a useful indicator in assessing releases from phoshy waste ponds and precipitator slurry.

Given the widespread occurrence of elevated potassium in groundwater in these areas, it is likely that the gross beta levels are attributable to the presence of potassium-40, a naturally occurring beta-emitting isotope.

Within this general context, the following constituent associations can be recognized for the two FMC areas.

Southwestern Area. Since FMC has not substantially altered its in-plant operations over the years, the wastestreams that are currently being generated should contain the same type and concentration of constituents managed in the former ponds in the southwestern area. The southwestern area was and is a recipient of phoshy wastes and precipitator slurry; however, these wastes are currently discharged into lined ponds.

Arsenic, selenium, chloride, fluoride, total phosphorus, potassium, and sodium are the more mobile constituents found in phoshy wastes and precipitator slurry. These constituents would likely be found together in groundwater that has been impacted by past releases, though not necessarily at the same ratios that are found in the ponds. As was noted in the potential source section, the values discussed previously are for total analyses rather than filtered analyses. Consequently, the concentrations of the dissolved constituents that would have been available for transport from the source areas are probably lower.

Central Area. The central area is similar in waste profile to the southwestern area except that there are fewer and smaller ponds, all of which historically received phoshy wastes and precipitator slurry. The primary characteristic constituents found in groundwater are arsenic, chloride, fluoride, orthophosphate, total phosphorus, potassium, and sodium combined with low concentrations of calcium. The slag pit also provides a thermal tracer from its heating of the underlying soils and groundwater.

4.4.2.3 Nature and Extent of Site-Related Constituents in the Southwestern Area

The presentation of the nature and extent of site-related constituents is subdivided with respect to areas north and south of the mixing zone of groundwater originating in this area, and with trends toward the northeast.

Common Ions and Physical Parameters of Wells North and West of the Mixing Zone. Five wells located north and west of the mixing zone (112, 126, 127, 128, and 148) were found to have general water chemistry comparable to the Michaud Flats regime characterized by Wells 101, 102, 147, and TW10S, and are considered to be unimpacted by EMF facilities operations.

Mean concentrations of alkalinity as bicarbonate (181 mg/l) and calcium (95.2 mg/l) were marginally higher in the five wells than the concentrations in the four representative wells (154.6 mg/l and 85.0 mg/l, respectively). However, concentrations were within the ranges for the 16 representative wells (315 mg/l and 105 mg/l, respectively) (Table 4.4-1). Mean sodium (73.1 mg/l) and sulfate (84 mg/l) concentrations were higher in these five wells than the representative concentrations for Michaud Flats (42.5 mg/l and 52 mg/l), and higher than overall representative concentrations (63 mg/l and 79 mg/l). However, these higher concentrations reflect natural trends in Michaud Flats groundwater and not any site-related impact (Appendix M). This conclusion is supported by the fact that mean concentrations for chloride and potassium, which are indicator parameters for southwestern pond releases, were essentially the same as mean concentrations for the four representative wells.

Mean values of physical parameters (pH, specific conductance, temperature, TDS, and redox) for the nine wells as a group were comparable to mean values of the four Michaud Flats representative wells (Table 4.4-1). Mean specific conductance (1,056 μ mhos/cm) was higher than the representative concentration for Michaud Flats groundwater (839.7 μ mhos/cm), but was comparable to the upper limit (1,049 μ mhos/cm) for the 16 representative wells. Mean TDS (643 mg/l) was marginally higher than the representative concentration for Michaud Flats groundwater (542.4 mg/l) but was below the upper representative limit (746 mg/l). Temperature ranged from 12.1°C to 16.8°C, comparable to that for the four representative wells (10.2°C to 16.8°C), and pH ranged from 6.98 to 7.64 for the five wells, also comparable to pH for the four representative wells (7.15 to 8.53).

These data for unimpacted FMC wells monitoring Michaud Flats groundwater suggest that naturally occurring Michaud Flats groundwater may have bicarbonate, calcium, sodium, and sulfate concentrations that exceed the representative ranges. This is expected due to a criterion used to select representative wells—that the groundwater geochemistry from wells within a hydrogeologic area be similar. This criterion may artificially reduce the variability in the representative groundwater database by forcing the selection of wells with similar geochemistry. True representative conditions in the Michaud Flats regime appear to have a high variability; therefore, ranges of representative concentrations are not accurately reflected in the set of wells that were selected because they exhibited similar geochemical properties.

Several wells north and west of the mixing zone are in the Bannock Range regime. Using Stiff diagram analysis of common ion proportions and actual common ion concentrations, Wells 124, 125, 129, 149, 153, 154, TW-3D, TW-5D, TW-5I, and FMC-6 were found to have general water chemistry comparable to the low-ionic-concentration calcium-bicarbonate water chemistry of the Bannock Range regime (Figure 4.4-14).

The mean sodium concentration (46.7 mg/l) was higher than the mean for the Bannock Range regime (20.4 mg/l); it was within the range for representative wells (5 to 50 mg/l). Because potassium, chloride, and sulfate were not elevated, it can be concluded that the slightly higher sodium value was naturally occurring.

The mean values of physical parameters (pH, specific conductance, temperature, TDS, and redox) for the Bannock Range FMC wells (Table 4.4-6) were generally comparable to mean values of the Bannock Range representative wells (Table 4.4-1). Mean specific conductance (697 $\mu\text{mhos/cm}$), temperature (15.8°C), and TDS (438 mg/l) were within the representative ranges for high-chloride and low-chloride Bannock Range groundwater. The range of pH (6.93 to 8.99) for the group of wells was within the broader range (6.91 to 9.40) of the low-chloride subgroup.

Metals in Wells North and West of the Mixing Zone. All the wells examined above had mean metal concentrations below the upper limit for representative wells for all parameters except nickel.

Arsenic concentrations detected in unimpacted wells monitoring Michaud Flats groundwater ranged from 0.004 to 0.026 mg/l, with the exception of one measurement of 0.092 mg/l in Well 127. As this well is located upgradient or crossgradient from potential sources, the single higher arsenic measurement was an outlier. Arsenic concentrations detected in unimpacted Bannock Range wells ranged from 0.002 to 0.038 mg/l. These concentrations were within the representative range for the Bannock Range representative wells (0.015 to 0.039 mg/l). Hence arsenic was not present as a site-related constituent in the wells to the west and north of the mixing zone.

Lithium concentrations detected in unimpacted wells monitoring Michaud Flats groundwater ranged from 0.036 to 0.071 mg/l (Table 4.4-7). These lithium concentrations were consistent with a trend of increasing concentrations found in wells to the north and west of well pair 101/102 (Section 4.4.1.3). Lithium concentrations in unimpacted Bannock Range wells ranged from 0.005 to 0.077 mg/l. Highest concentrations were in Wells 154, 124, and 149, and at the time of sampling, all of these wells were located upgradient of potential sources. A new lined pond (16S) was placed in service in 1993 and Wells 124 and 149 are downgradient of this pond.

Constituents Present in Groundwater South and East of the Mixing Zone.

Twenty-three wells in the former ponds area were within or south of the mixing zone. Wells 113, 114, 115, and 137 are located in the immediate vicinity of former Ponds 5E and 6E. Wells 113 and 137 can be used to define the northern and southern extent of elevated constituents in groundwater in the far southwestern portion of the former ponds area. Wells 114 and 115 lie immediately downgradient of and within a possible zone of impacted groundwater extending from former Ponds 5E and 6E, and possibly Ponds 3E and 4E (Figure 4.4-10).

Well 113 is located downgradient from the northwestern edge of Pond 5E and is probably within the mixing zone between Michaud Flats and Bannock Range groundwater. While arsenic concentrations in Well 113 were sometimes within the representative range, they were generally above this range (0.035 to 0.040 mg/l), which would indicate slight arsenic enrichment (Figure 4.4-15).

Well 113 had moderately elevated boron concentrations (generally around 80 mg/l) and elevated potassium (31.4 to 45.8 mg/l) and nitrate (6.2 to 7.6 mg/l) concentrations. Boron concentrations detected in unimpacted Michaud Flats wells ranged from 0.05 to 0.63 mg/l, with the highest concentrations in Wells 128 and 127. Well 113 appears to be located near the edge of the zone of impacted groundwater.

Arsenic concentrations in Well 137 were above (0.093 mg/l) the range for representative wells (0.032 mg/l). In addition, chloride (151 to 189 mg/l), sulfate (106 to 150 mg/l), and total phosphorus (1.6 to 7.8 mg/l) were above representative concentrations.

Well 137 is located within the boundary of former Pond 6E and is within the upgradient margin of a zone of impacted shallow groundwater that contains above-representative concentrations of arsenic, boron, chloride, manganese, nitrate, total phosphorus, and sulfate associated with the area of former Ponds 5E and 6E. It delineates the approximate southern boundary of the southwestern area plume.

Wells 114 and 115 had elevated concentrations of the following metals: arsenic, boron, cobalt, lithium (Well 115 only), manganese, and selenium (Well 114 only). These two wells also had elevated concentrations of phosphate, sodium, and sulfate. Specific conductance, bicarbonate, and TDS concentrations were elevated in these two wells, but calcium concentrations were much less (47.6 and 49.9 mg/l, respectively) than the mean in representative wells. Calcium was also very low in the representative potential source samples.

Wells 103, 104, 116, 131, and 132 had elevated common ion concentrations and are located in the immediate vicinity of former Ponds 1E, 2E, 3E, and 4E. Wells 131 and 132 are also located within the mixing and dilution zone that contains groundwater from beneath the area of former Ponds 5E and 6E.

Arsenic concentrations in shallow Well 104 ranged from 0.127 to 0.229 mg/l. Arsenic concentrations in deeper Well 103 (0.030 to 0.036 mg/l) were near the upper range for representative wells (0.032 mg/l). Well 104 is located within a zone of arsenic-impacted groundwater possibly associated with former Ponds 1E and 2E. Arsenic from this source may also have impacted deeper groundwater at this location, as evidenced by the slightly elevated arsenic in deeper Well 103.

Arsenic concentrations varied greatly in Well 116 during the RI sampling program, ranging from 0.022 to 0.113 mg/l. For most sampling events, concentrations exceeded the representative range.

Well 131 lies downgradient of former Ponds 1E through 4E and may be within the mixing and dilution zone downgradient of the zone of impacted groundwater extending from the extreme southwest (Figure 4.4-10).

Arsenic concentrations in deeper Well 131 (0.017 to 0.059 mg/l) were elevated compared to the representative concentration (0.032 mg/l), but were less than nearby Wells 104 and 116 and less than upgradient Wells 114 and 115. Other metals at elevated concentrations included boron, cobalt, copper, and manganese. Phosphate was also elevated in Well 131 (Figure 4.4-2).

Well 132 lies downgradient of former Ponds 1E through 4E and is within the mixing and dilution zone downgradient of impacted groundwater extending from the southwest. Well 132 had arsenic and other metal concentrations plus elevated common ion concentrations. Nutrients were also present in Well 132 above representative levels.

A zone of lithium-impacted groundwater appears to extend to the northeast from the area of former Ponds 5E and 6E and into the mixing zone monitored by Wells 132 and 140 (Figure 4.4-16). This zone may be associated with the lithium detected by Wells 104 and 116, and Wells 150 and 152 downgradient of Pond 8S. This zone may also extend to the northern portion of the central area, exiting the site near monitoring Well 111 (Figure 4.4-11).

Wells 117, 118, 150, 151, 152, and 159 had elevated common ion concentrations and are located in the immediate vicinity of Pond 8S. Well 151 is located between Pond 8S and former Ponds 5S and 10S.

Well 118 contained arsenic (0.037 mg/l) at levels just above the upper limit for representative levels. Neither arsenic nor any other metal or nutrient parameter was elevated in deeper Well 117. Well 118 is on the eastern edge of a zone of impacted groundwater emanating from Pond 8S. Deeper groundwater appears to be impacted to a minor degree as well, as evidenced by higher sulfate concentrations (277 mg/l) in deeper Well 117.

Wells 150 and 152 lie downgradient of Pond 8S. Wells 150 and 152 had elevated arsenic concentrations (0.15 and 0.18 mg/l, respectively). Other metals at elevated concentrations in these wells included boron, cobalt, and lithium. Concentrations of ammonia, phosphate, and fluoride in these wells were the highest concentrations found in the southwestern area. Calcium concentrations (34 and 77 mg/l) were below the average for representative wells, as would be expected by the low calcium values of the water contained in Pond 8S.

Wells 150 and 152 had the most elevated bicarbonate (1,482.5 and 1,268.5 mg/l), specific conductance (5,973 and 4,951 μ mhos/cm, respectively), and TDS (4,918 and 4,274 mg/l, respectively) concentrations for all wells in the southwestern area. These two wells also had the most strongly negative redox potential (-190 to -306 mV, respectively). Representative wells generally have positive redox potential.

Well 151 is approximately 700 feet downgradient from Pond 8S. Arsenic was detected at concentrations above the upper representative limit during three rounds of sampling in Well 151 (mean concentration of 0.05 mg/l). In two other sampling events, arsenic concentrations were qualified as nondetect by the validation process due to contaminated field blanks. These nondetect values were both above representative concentrations. Well 151 is most likely near the eastern margin of a zone of arsenic-impacted groundwater emanating from Pond 8S. Boron was detected at elevated concentrations (1.07 mg/l) in Well 151. Well 151 also had moderately elevated levels of phosphorus (22.3 mg/l) and orthophosphate (8.40 mg/l).

Well 140, which had elevated common ion concentrations, is located approximately 500 feet downgradient from former Pond 7S. It is also downgradient from former Ponds 1E, 2E, and 6S, as well as Pond 8S. This well is also located within the mixing and dilution zone that contains groundwater flowing beneath former Ponds 1E through 6E.

Arsenic was detected at concentrations up to 0.047 mg/l in Well 140. Other metals at elevated concentrations include boron (1.23 mg/l), lithium (0.121 mg/l), and selenium (0.02 mg/l). Fluoride was slightly elevated above the highest representative concentration (Well 140: 3.4 mg/l versus 1.2 mg/l for representative wells). Well 140 had the highest sulfate concentrations (669 mg/l) and the single highest sodium concentration (1,100 mg/l in June 1992) for all wells in the southwestern area. However, in subsequent rounds of sampling, sodium concentrations for Well 140 were much lower (273 to 281 mg/l). The June 1992 sodium value was heavily qualified in the validation process and should be used only as an indication that sodium is present at elevated levels. Total phosphorus was detected at 15.7 mg/l and orthophosphate at 1.84 mg/l in Well 140 (August 1993 sampling).

Well 141 is located near and approximately 100 feet downgradient from former Ponds 5S and 10S, while Well 135 is approximately 300 feet to the east-northeast. Well 135 is potentially downgradient of Pond 8S and within the mixing zone that contains groundwater from beneath the area of all former ponds.

Well 135 had concentrations of arsenic ranging from 0.042 to 0.067 mg/l. These concentrations suggest that Well 135 may monitor the eastern margin of a zone of arsenic-impacted groundwater emanating from the south. No other metals were at elevated concentrations in Well 135. This well also had slightly elevated concentrations of nitrate and phosphate (4.04 mg/l total phosphorus and 4.00 mg/l orthophosphate).

Well 141 had elevated arsenic concentrations (0.1 mg/l). Boron (1.3 mg/l), lithium (0.07 mg/l), and total phosphorus (55.8 mg/l) were moderately elevated in Well 141.

Summary for Southwestern Area. In the former ponds area, all 23 FMC monitoring wells had elevated common ion concentrations and elevated concentrations of one or more metals, nutrients, and radiological parameters.

Constituents most commonly found at elevated concentrations in groundwater in the former ponds area were arsenic, boron, cobalt, copper, lithium, and selenium; ammonia, fluoride, nitrate, and two phosphate parameters; common ion parameters; the physical parameters specific conductance, temperature, and TDS; and the radiological parameters gross alpha and gross beta. The pH of impacted groundwater in FMC former ponds is typically lower than representative levels.

Three of the 23 impacted wells in the southwestern area had elevated gross alpha activities during one sampling event. Nine of the 23 impacted wells had elevated gross beta activities.

Volatile organic compounds were generally not detected in groundwater in the former ponds area.

Wells downgradient of the slag piles (Wells 106, 119, and 158) did not have elevated concentrations of any parameter. Furthermore, the onsite soil investigation in Section 4.2 determined that subsurface soils beneath areas where slag has been deposited are not impacted to any depth. Hence the constituents found in slag are immobile and do not appear to have impacted the groundwater.

4.4.2.4 Nature and Extent of Site-Related Constituents in the Central Area

Former Ponds 1S through 3S, the furnace building, and the slag pit are located in the central FMC area. The location of Ponds 0S and 00S is not known for certain, but it appears that the ponds are in the central area. This area includes the railroad swale at the northern facility boundary. In the main plant area there are shops that handle

oils and degreasers that may be sources of constituents such as trichloroethene. The locations of these areas are shown in Figure 1.1-1.

Groundwater flow in the central area of the FMC facility (Figure 4.4-11) follows a more north-by-northeast pattern than that found in the southwestern area. The flowpath of the mixing and dilution zone from the southwestern area enters the central area near Well 134, passing beneath the area of former Ponds 1S through 3S. This flowpath then passes beneath the western end of the railroad swale and exits the FMC operations area near Well 111.

Wells 133 and 134, located in the immediate vicinity of former Ponds 1S, 2S, and 3S, had elevated common ion concentrations. This well pair is also located within the mixing and dilution zone that contains groundwater impacted by the former ponds in the southwestern area (Figure 4.4-11).

Shallow Well 134 had elevated arsenic (0.13 mg/l) concentrations as well as elevated boron (1.29 mg/l), lithium (0.098 mg/l), manganese (3.60 mg/l), phosphate (34.65 mg/l), and potassium (187.5 mg/l) concentrations. Deeper Well 133 did not have elevated concentrations of metals or nutrients; only sulfate (140.5 mg/l) appeared to be elevated in this well.

While boron concentrations in Well 134 were elevated, they were less than or equal to concentrations in southwest-area Well 141 for each sampling event. Elevated boron concentrations in Well 134 most likely represent the zone of boron-impacted groundwater originating in the southwestern area. Ponds 1S, 2S, and 3S do not appear to be significant sources of boron in groundwater beneath the FMC facility.

In the northern portion of the central area, Wells 111, 122, and TW-5S with elevated common ion concentrations are located downgradient of the main FMC plant area and the northern margin of the furnace building. These wells are along the groundwater flowpath emanating from the southwestern area. Well 111 is also downgradient from the railroad swale. Wells TW-5I and TW-5D, which are the deeper of the TW-5 cluster, were not impacted, indicating the impacted groundwater in this area is confined to the shallow zone.

Well 111 is located due north of the main plant area just outside the fenceline. Metals were present at slightly to moderately elevated concentrations, including arsenic (0.52 mg/l), boron (0.95 mg/l), cobalt (0.017 mg/l), lithium (0.095 mg/l), manganese (1.21 mg/l), and selenium (0.003 mg/l). Nitrate (17.35 mg/l), phosphorus (17.38 mg/l), and potassium (143 mg/l) were also slightly to moderately elevated in Well 111.

Orthophosphate in groundwater in the central area appears to be an extension of the zone of impacted groundwater originating near former Ponds 1E and 2E and Pond 8S. The zone extends from the upgradient margin of the central area, along the

northern portion of the central area, and exits the FMC facility (fenceline, but not property boundary) in the vicinity of Well 111 (Figure 4.4-2).

Well 122 is located within the northern portion of the main plant building area. Metals were present at slightly to moderately elevated concentrations, including arsenic (0.065 mg/l). Other metals found in upgradient wells were generally not present. Ammonia (1.26 mg/l), nitrate (18.2 mg/l), phosphate (9.31 mg/l), and potassium (236 mg/l) were also present at elevated concentrations in Well 122.

Monitoring Well TW-5S is located due north of the main plant area. Metals present at slightly to moderately elevated concentrations included arsenic (0.063 mg/l), boron (0.68 mg/l), and lithium (0.094 mg/l) (Table 4.4-9). Nitrate (26.8 mg/l) was elevated in Well TW-5S. Ammonia (0.933 mg/l), phosphorus (8.07 mg/l), and potassium (218 mg/l) were slightly to moderately elevated (Tables 4.4-10 and 4.4-11).

Wells 121, 108, and 146 monitor the flowpath that passes beneath the slag pit area and were impacted, based on common ion concentrations. Well 107, which is the deeper of the 107/108 pair, had representative-quality groundwater. This is an indication that the impacted groundwater detected in this area is confined to the shallow zone.

Metals data for Wells 121, 108, and 146 are summarized in Table 4.4-9. As shown, mean concentrations of boron (0.53 mg/l), lithium (0.061 mg/l), manganese (0.33 mg/l), and selenium (0.032 mg/l) for the three wells exceeded the upper limit for representative wells.

In Wells 121, 108, and 146, mean concentrations of nitrate (14.4 mg/l) and fluoride (1.7 mg/l) exceeded the upper limit for representative wells (Table 4.4-10). Ammonia was not detected, and the two phosphate parameters were detected within representative ranges.

For Wells 121, 108, and 146, mean concentrations of potassium (139 mg/l), sodium (105 mg/l), sulfate (211 mg/l), specific conductance (1,679 μ mhos/cm), temperature (23.8°C), and TDS (1,086 mg/l) exceeded representative concentrations (Table 4.4-11). Other common ion concentrations were comparable to representative concentrations.

Wells 121, 108, and 146 all had elevated gross beta activities, ranging from 3.27 to 186 pCi/l (Table 4.4-12). This may be related to the elevated potassium concentrations.

Several volatile organic compounds, most consistently TCE, were detected in groundwater in this area (Table 4.4-13). Concentrations of TCE ranged from 0.002 to 0.015 mg/l in Wells 108, 146, and 121.

Summary for the Central Area. Groundwater flowpaths beneath the slag pit and downgradient from the slag pit are influenced by the convergence of flow from the Michaud Flats and Bannock Range hydrogeochemical regimes from the southwestern portion of the FMC facility, and additional northerly flow of Bannock Range groundwater.

In the southern part of the central area, this northern flow is paralleled by northerly flowing Bannock Range groundwater that passes beneath the slag pit and the southern portion of the furnace building and then toward monitoring Well 146, beyond which it exits the facility. However, this impacted groundwater subsequently returned to the EMF facilities through capture by the Simplot production wells.

Maximum lithium concentrations were generally lower in the slag pit area than in the southwestern area (Figure 4.4-16). This figure shows that shallow Wells 108, 111, 122, 134, and TW-5S had elevated lithium concentrations ranging from 0.08 to 0.16 mg/l. Lithium concentrations in Wells 111 and 134 were generally greater than concentrations in southwest-area Well 141. Elevated lithium concentrations in Wells 134 and 111 may reflect an additional source of lithium added to the impacted groundwater originating in the southwestern area.

Elevated potassium concentrations extend from Well 134, downgradient of former Ponds 1S through 3S, through Wells TW-5S and 111 (Figure 4.4-17).

In the southern portion of the central area, Wells 108, 121, and 146 contained elevated common ion concentrations and are located downgradient of the slag pit and the furnace building. These wells may intercept the southern margin of groundwater flow from the southwestern area. The higher potassium concentrations in Wells 108 and 122 suggest an additional source in the vicinity of the furnace building.

The high temperatures in Well 108 extend to Well 146 and appear to be present in offsite Well 517 (Figure 4.4-18).

Well 121 is located at the upgradient margin of the slag pit, Well 108 is located at the downgradient margin of the slag pit, and Well 146 is located just outside the fenceline approximately 1,600 feet northeast and downgradient of the slag pit. Although common ion concentrations were elevated in these wells, all three wells had representative levels of arsenic. Selenium was elevated in Well 121 and decreased to slightly elevated concentrations in Wells 108 and 146. Nitrate and potassium were slightly to moderately elevated in these wells.

The zone of nitrate-impacted groundwater originating in the southwestern area appeared to extend into the central area to Wells 121, TW-5S, and 111. Wells 122 and 108, near the furnace building and slag pit, appeared to lie within another zone

of nitrate-impacted groundwater. Nitrate concentration trends are similar for Wells 135 and 121. The trends discernible in Wells 122 and 108 are similar, but differ from the trends observed in Wells 135 and 121, indicating Wells 122 and 108 monitor a different zone of impacted groundwater.

The presence of fluoride in groundwater in the FMC central area was limited to the vicinity of the slag pit.

Well 108 had the highest sulfate concentrations (154 to 316 mg/l) in the central FMC area. Well 108, which is due northeast and directly downgradient from the furnace operations, had an average temperature of 86°F (30°C) (Figure 4.4-18). This thermal plume is detected in Well 122 and extends to Well 146, at the fenceline. Wells 108, 122, and TW-5S were the only wells in the central area with negative redox potential.

Well 121, and to a lesser extent, Wells 108 and 146 had detectable levels of VOCs, TCE in particular.

4.4.3 Characterization of Groundwater Quality at Simplot

This section discusses the eastern area of Simplot, which encompasses the former east overflow pond, the lower gypsum stack, and the eastern two-thirds of the upper gypsum stack (Figure 4.4-6). Most of the Simplot production facilities are also in this area.

Groundwater from the Portneuf River Valley and Bannock Range hydrogeochemical regimes underflows the eastern Simplot facilities. As stated previously, the Portneuf River hydrogeochemical regime has a calcium-bicarbonate groundwater chemistry, and the Bannock Range geochemistry is similar, but with lower ion concentrations. Michaud Flats groundwater does not flow under this area.

Overview of Findings

Groundwater in this area begins its flowpath in the higher elevations of the Bannock Range and flows beneath the upper gypsum stack. Continuing downgradient, groundwater flows beneath the lower gypsum stack and continues, for the most part, to the Simplot production wells. Upward vertical gradients are present throughout the lower gypsum stack area and the main plant area of Simplot (Figures 3.3-5A to 3.3-5E). These upward hydraulic gradients prevent downward vertical migration of constituents emanating from the gypsum stacks and flowing horizontally through the uppermost saturated gravel zone. There are deeper wells (i.e., Well 317) in the eastern Simplot area where impacted groundwater is detected, but these areas appear to be localized. Deeper groundwater, for the most part, is unimpacted.

The constituents present above representative concentrations in groundwater beneath both the upper and lower gypsum stacks were ammonia, arsenic, bicarbonate, boron, calcium, lithium, magnesium, orthophosphate, potassium, reduced pH, total phosphorus, selenium, sodium, sulfate, and gross beta. Groundwater beneath the upper gypsum stack also contained elevated levels of gross alpha. Groundwater beneath the lower gypsum stack also contained elevated concentrations of fluoride, and nitrate.

The primary constituents of potential concern appear to be arsenic, fluoride (former east overflow pond area), selenium, sulfate, chloride, sodium, and nitrate.

Most of the groundwater flowing beneath the gypsum stack appears to flow into the cone of depression of the Simplot production wells. The production well capture zone appears to extend to the east to a point between Wells 318 and 328 (Figure 4.4-18).

Wells 305 and 328, and the wells along the Portneuf River did not contain concentrations of gypsum stack constituents at elevated levels, indicating that EMF-related activities did not impact groundwater beyond the eastern Simplot boundary.

In the area of the former east overflow pond, constituents detected above representative concentrations were aluminum, ammonia, arsenic, beryllium, bicarbonate, boron, cadmium, calcium, total chromium, cobalt, copper, fluoride, lithium, magnesium, manganese, nickel, nitrate, orthophosphate, reduced pH, potassium, selenium, sodium, sulfate, thallium, and zinc. The occurrence of most of these constituents appeared to be limited to Well 318, located immediately downgradient from the former east overflow pond. The lower zone of the aquifer in this area also contained slightly elevated levels of constituents that can be associated with the former pond. The extent of migration of releases is uncertain and is being further evaluated by modeling techniques; it is possible that slightly elevated levels of nickel, fluoride, and lower pH detected in Wells TW-12S, 320, and 503 may be related to releases from this former pond.

4.4.3.1 Identification of Constituents of Potential Concern in Simplot Groundwater

The analytical results obtained from groundwater samples collected during the RI were evaluated to identify:

- Constituents that could be eliminated from further consideration either because they were not present at levels that exceeded representative concentrations, or because they were detected sporadically at concentrations very close to the detection level

- Constituents that were site related, or that could be used as indicators of releases from source areas within the Simplot facility

This process served to simplify the identification and description of the nature and extent of site constituents present in groundwater associated with source areas within Simplot. Comparison of common ion concentrations with representative groundwater indicated that 14 wells in the eastern Simplot area were impacted.

Constituents Eliminated. First, as described in Sections 4.4.1.2 and 4.4.1.3, six parameters were eliminated as site-related parameters for all 130 EMF wells (both onsite and offsite wells, and both impacted and unimpacted wells): antimony, lead, molybdenum, silver, barium, and mercury. Next, the representative levels for constituents in groundwater, described in Section 4.4.1.1, were compared with analytical results from wells at Simplot that were not part of the representative well network. This comparison identified a number of constituents that were present only in concentrations at or below representative levels in groundwater beneath the Simplot facility in all wells except Well 318. The results of this comparison, presented in Table 4.4-14, indicate that cobalt, iron, thallium, vanadium, and zinc were not present at representative levels in groundwater beneath Simplot. These five metals were found at elevated levels in groundwater samples collected from Well 318, as a result of the low pH of the groundwater, but were not detected in groundwater downgradient from this well.

Beryllium, cadmium, chromium, and copper were detected sporadically at concentrations just above (e.g., within several parts per billion) their detection levels (with the exception of Well 318). These constituents are believed to be naturally present in groundwater. Their presence at concentrations just above the upper limit for representative levels is likely due to natural variability not reflected in the samples collected from the representative wells.

Aluminum was also detected sporadically, but at concentrations well above representative levels. As discussed in Section 4.4.1, the presence of aluminum is believed to be due to silt accumulation in specific monitoring wells. With the exception of Well 318, aluminum is not believed to be associated with releases from source areas.

It was concluded that the 14 metal constituents identified in Table 4.4-14, plus volatile and semivolatile organic compounds, are not constituents of potential concern in groundwater beneath the Simplot facility. These constituents were therefore eliminated from further consideration except as noted for Well 318.

Metal Constituents Detected in Groundwater. In wells with elevated common ion concentrations, arsenic, boron, and lithium were found at elevated concentrations within the Simplot facility. Figures 4.4-19, 4.4-20, and 4.4-21 show the areal distribution of these parameters in groundwater for the March 1993 RI

sampling round. These three metals are site-related constituents in groundwater. However, arsenic and lithium were more widely distributed than was boron (attenuation appears to be more rapid for boron). In addition, arsenic and lithium were more elevated with respect to representative levels than was boron. Arsenic was present at mean concentrations up to 0.557 mg/l; lithium was present at mean concentrations up to 0.427 mg/l; and boron was present at mean concentrations up to 0.734 mg/l. Arsenic and lithium, therefore, are better indicators of impacted groundwater than is boron.

Selenium and nickel are site-related constituents in groundwater near individual source areas. Selenium was detected at elevated mean concentrations in the gypsum stack area (0.025 mg/l) and near the former east overflow pond (up to 0.026 mg/l).

Nickel was detected at elevated mean concentrations (2.95 and 0.10 mg/l) in all samples from Wells 318 and 320, respectively, downgradient of the former east overflow pond. Nickel was detected at elevated concentrations in Wells 332 (0.036 mg/l) and PEI-5 (0.23 mg/l). These concentrations exceeded the upper limit for representative wells (0.01 mg/l).

Cadmium was detected at concentrations higher than the upper representative limit for all samples from Well 318 (mean of 3.19 mg/l), and one sample each from Wells 320 (0.012 mg/l), 332 (0.006 mg/l), and PEI-5 (0.008 mg/l). The representative concentration of cadmium was 0.006 mg/l.

As shown in Table 4.4-14, 16 metals were present at elevated concentrations in groundwater from Well 318, located next to the former east overflow pond. These metals included arsenic, boron, lithium, manganese, nickel, and selenium, which were also detected in other Simplot wells, and aluminum, beryllium, cadmium, chromium, cobalt, copper, iron, thallium, vanadium, and zinc.

Nutrients and Fluoride in Groundwater. Characterization of nutrients and fluoride in groundwater at Simplot was used as a means of identifying the nature and extent of site-related parameters in groundwater. Samples collected from the Simplot monitoring wells were analyzed for the following:

- Ammonia
- Nitrate
- Orthophosphate
- Total phosphorus
- Fluoride

Nutrient and fluoride analytical results for Simplot monitoring wells with impacted water chemistry are summarized in Table 4.4-15. All four nutrients and fluoride

were present at elevated concentrations in groundwater beneath portions of the Simplot facility.

The phosphate parameters are characteristic of site-related constituents in groundwater for the entire Simplot facility. Phosphate (orthophosphate and total phosphorus) was found at elevated concentrations in all impacted Simplot wells. Mean phosphate concentrations ranged from 6.2 to 176.3 mg/l (orthophosphate) and 6.3 to 173 mg/l (total phosphorus), and 2,390 mg/l and 2,880 mg/l (total phosphorus and orthophosphate, respectively) for Well 318. Representative phosphate concentrations were 1.8 mg/l for orthophosphate and 3.1 mg/l for total phosphorus.

Figure 4.4-22 shows the areal distribution of wells in which orthophosphate was detected in groundwater beneath all areas of the Simplot facility. This figure presents orthophosphate data for the March 1993 round of sampling.

Nitrate, ammonia, and fluoride were detected at elevated concentrations in fewer wells and at less-elevated concentrations than phosphate. Elevated nitrate concentrations were detected in samples from Wells 315, 316, 320, 325, 326, and 332; mean concentrations ranged from 5.34 to 66.70 mg/l (compared with the upper limit for representative levels of 4.5 mg/l). Elevated ammonia concentrations were detected in samples from Wells 313, 318, 320, and 325; mean concentrations ranged from 2.0 to 23.9 mg/l. Elevated mean fluoride concentrations were detected in Wells 318, 320, 327, and PEI-5; mean concentrations ranged from 1.10 to 9.8 mg/l, excluding Well 318, and 1,317 mg/l at Well 318.

Ammonia, nitrate, and fluoride are characteristic constituents for site-related impact on groundwater from individual source areas as follows:

- Ammonia and fluoride in the central area (upper gypsum stack)
- Nitrate in the eastern area (lower gypsum stack)
- Ammonia, nitrate, and fluoride (former east overflow pond area)

Other Constituents Detected in Groundwater. Table 4.4-16 presents a summary of common ion concentrations and physical parameter measurements in the Simplot monitoring wells with impacted water chemistry. Some common ions and physical parameters were impacted by the facility.

Sulfate is characteristic of site-related impact for the entire Simplot facility. Sulfate mean concentrations ranged from 283 to 2,702 mg/l, compared to the 79 mg/l upper limit for representative wells.

Gross alpha activities ranged from a low of 2.09 pCi/l in Well 321 to a high of 1,690 pCi/l in Well 318. The upper limit of gross alpha in representative wells was 7.97 pCi/l. Wells 313, 315, 316, and 325, in the vicinity of the gypsum stacks, had

elevated gross alpha activities (Table 4.4-17) compared to representative wells. Gross beta activities ranged from a low of 4.04 pCi/l in Well PEI-6 to a high of 1,163 pCi/l in Well 318. Gross beta was elevated in wells in the vicinity of the gypsum stacks except PEI-5 and, possibly, PEI-3.

In the former east overflow pond area of the Simplot facility, only Well 318 had elevated gross alpha at 1,691 pCi/l (the highest for all Simplot wells). Wells 317, 318, and 320 had elevated gross beta, with activities ranging from 17.59 to 1,163 pCi/l.

The sporadic detection of VOCs and SVOCs in groundwater samples from Simplot wells indicates that these organic parameters were not site-related constituents (Table 4.4-18). Of the 15 volatile or semivolatile organic compounds reported, most, or all, may not be present in groundwater. Several compounds represent common laboratory solvents, including methylene chloride, acetone, and plasticizers (phthalates). Compounds reported infrequently and at low concentrations, such as 2-butanone, tetrachloroethene, 1,1,1-trichloroethane, ethyl benzene, trichloroethene, xylenes, benzoic acid, and tetrahydrofuran, may represent an aberration in the analytical methodology and may not actually be present in the sample.

4.4.3.2 Nature and Extent of Site-Related Constituents in Groundwater at Simplot

The nature and extent of site-related constituents in groundwater is described for two source areas within the Simplot facility:

- **Central and Eastern Area** – encompasses the central and eastern upper gypsum stack, and the lower gypsum stack.
- **Former East Overflow Pond Area** – encompasses the former east overflow pond and the groundwater flowpath downgradient of the former east overflow pond; area also influenced by the gypsum stacks.

For ease of understanding, the discussion for each source area has been divided into a summary that is followed by a more detailed analysis describing the nature of sources and release mechanisms, chemicals present, the geographic extent of elevated constituents, and the relationship to groundwater flow.

Central and Eastern Area. The central and eastern portions of the Simplot facility present a complex groundwater flow regime. Throughout the central and eastern area, most of the groundwater flow originating from the upper and lower gypsum stacks was captured by the Simplot production wells.

The source of site-related constituents in groundwater in the central area of the Simplot facility was the infiltration from the upper gypsum stack. In the eastern area of the Simplot facility, the lower gypsum stack represented an additional source of constituents and may have added to the impact from the upper gypsum stack.

Chemicals Present at Elevated Concentrations in the Central and Eastern Area. The constituents present at above-representative concentrations in groundwater beneath both the upper and lower gypsum stacks were ammonia, arsenic, bicarbonate, boron, calcium, lithium, magnesium, orthophosphate, potassium, reduced pH, total phosphorus, selenium, sodium, sulfate, and gross beta. Groundwater beneath the upper gypsum stack also contained elevated levels of gross alpha. Groundwater beneath the lower gypsum stack also contained elevated concentrations of fluoride and nitrate. Tables 4.4-14, 4.4-15, and 4.4-16 present the mean concentrations of constituents detected in wells within this area and the associated concentrations of representative groundwater for these constituents.

Selenium was present at elevated concentrations in groundwater beneath the central (upper gypsum stack) area of the Simplot facility. Concentrations ranged from 0.009 to 0.214 mg/l. Nickel was also detected at an elevated concentration (0.44 mg/l) in one sample from Well PEI-5. This concentration exceeded the upper limit for representative groundwater (0.01 mg/l).

Selenium was present at elevated concentrations in groundwater beneath the eastern (lower gypsum stack) area of the Simplot facility. Mean selenium concentrations for the three shallow Wells 316, 326, and 332 ranged from 0.016 to 0.037 mg/l. Cadmium was detected at the representative concentration of 0.006 mg/l in Well 332.

Nutrients and fluoride were present at elevated concentrations in groundwater beneath the central and eastern area of the Simplot facility. For the wells monitoring these areas, the two phosphate parameters were detected in nearly all samples and at consistently elevated concentrations in all wells. Mean concentrations of orthophosphate ranged from 8.11 to 176.25 mg/l, and mean concentrations of total phosphorous ranged from 7.71 to 173 mg/l. As shown in Table 4.4-15, ammonia was encountered only in Wells 313 and 325; the mean concentrations were 6.1 mg/l and 2.00 mg/l, respectively. Fluoride and nitrate were detected in most samples; however, elevated mean fluoride concentrations were limited to Well PEI-5 (9.80 mg/l). Elevated nitrate concentrations were limited to Wells 313 (57.9 mg/l), 325 (24.4 mg/l), 316 (13.9 mg/l), and 326 (14.4 mg/l).

Mean concentrations of ammonia, nitrate, orthophosphate, total phosphorus, and fluoride exceeded the upper representative limits (Table 4.4-15). All of the elevated ammonia concentrations and the highest nitrate concentrations were in Wells 313 and 325, located within the process operations area of the Simplot facility.

Maximum concentrations of all common ion parameters except chloride, plus specific conductance and TDS, exceeded representative concentrations for groundwater from the central and eastern area of the Simplot facility (Table 4.4-16). Sulfate concentrations greater than 1,000 mg/l were found in wells in these areas of the Simplot facility.

pH ranged from 4.65 to 6.82 (more acidic than representative values) for all but two samples. Temperature measurements were above representative levels for all samples from Well 315 (18.0 to 18.5°C) and for some samples from Wells 306, 325, and PEI-5 (13.3°C to 18.9°C).

Wells 306, 313, 315, 316, and 325 monitoring the central and eastern area of the Simplot facility had elevated gross alpha activities (Table 4.4-17) compared with representative wells for at least one round of sampling. Gross alpha activities ranged from 8.69 to 46.5 pCi/l, with the greatest activity detected in Well 306. Gross beta was elevated in all wells except PEI-5, and possibly PEI-3. Gross beta activities ranged from 18.9 to 50.7 pCi/l, with the greatest activity detected in Well 316. The highest radiological parameter activities were found in the deeper wells, suggesting that these parameters may be related to natural sources in the underlying bedrock rather than to the gypsum stacks.

Extent and Relationship to Flowpaths of Elevated Constituents in Groundwater beneath the Central and Eastern Area. Groundwater flowpaths in this area of the Simplot facility are influenced by the hydraulic head induced by infiltration from the upper gypsum stack. This head induced flow toward the northwest, north, and northeast. Prior to the construction of the gypsum stack and in areas currently upgradient of the gypsum stack, natural flow, consisting of Bannock Range regime groundwater originating from recharge in the Bannock Range, flowed from south to north.

The infiltration from the sustained head on the upper gypsum stack is substantially reduced by the low permeability of the gypsum and the attenuating capacity of the underlying silts (Figures 4.2.2-5 through 4.2.2-10, which illustrate the distribution of silt beneath the unit). Gypsum may also precipitate in pore spaces of the underlying silts, further reducing permeabilities of the natural geologic material (Dames & Moore, 1975). This precipitation, if it occurs, is a result of the marked change in physicochemical environment between the low-pH, supersaturated gypsum stack fluids and the high-pH, carbonate-buffered loess. As discussed in Section 4.2.2, other metals found in the gypsum stack supernatant are rapidly attenuated.

Potentiometric head elevations near the upper gypsum stack were slightly elevated. However, as described in Section 3.3, these heads did not appear to be great enough to induce a full radial mounding effect. The naturally high hydraulic gradients in the underlying Bannock Range groundwater system beneath the upper gypsum stack may dissipate head under the gypsum stack quickly enough to minimize head buildup.

Groundwater in the central area and some of the groundwater to the east appeared to be captured by the Simplot production wells, based on the analyses performed to date. Some groundwater flowing between Wells 318 and 328 may not have been captured by the production wells. Groundwater flowed northward where it met the

flow in the Michaud Gravel. Some water flowing through this area was captured by the Simplot production wells.

All of the elevated ammonia concentrations and the highest nitrate concentrations were detected in Wells 313 and 325 within the process operations area of the Simplot facility, suggesting that additional ammonia and nitrate was released to groundwater from these operations. Other elevated, but lower, nitrate concentrations were present in Wells 315, 316, and 326, downgradient of the lower gypsum stack.

Former East Overflow Pond Area. The former east overflow pond is located in the northeastern area of the Simplot facility. Groundwater from the upper and lower gypsum stacks passes beneath the former east overflow pond.

During the period of the RI sampling program, the former east overflow pond was active and episodic discharges of plant process water to the unlined pond infiltrated through subsurface gravels to groundwater. Wells 317 and 318, at the downgradient margin, were impacted. In Well 318, this resulted in elevated metal concentrations and pH less than 2, as well as elevated concentrations of nutrients and common ions. Moderately elevated levels of many of the same constituents were also detected in Well 317, which is screened in the deeper zone of the aquifer. The former east overflow pond has since been taken out of service and replaced with a new lined pond constructed nearby. Groundwater impacts are expected to dissipate.

Chemicals Present at Elevated Concentrations in the Former East Overflow Pond Area. Constituents most commonly found at elevated concentrations in groundwater in the former east overflow pond area are summarized below. The mean concentrations from Wells 317, 320, and 327 located downgradient from the former east overflow pond were arsenic (0.181 mg/l), boron (0.42 mg/l), calcium (277 mg/l), lithium (0.170 mg/l), magnesium (133 mg/l), orthophosphate (55 mg/l), potassium (19.4 mg/l), sodium (303 mg/l), and sulfate (1,106 mg/l). In addition, the following constituents were also found at elevated mean concentrations in groundwater downgradient of the former east overflow pond: bicarbonate (746 mg/l), ammonia (8.5 mg/l), fluoride (2.1 mg/l), manganese (0.267 mg/l), nickel (0.06 mg/l), nitrate (26 mg/l), and selenium (0.010 mg/l). In Well 318, located at the downgradient margin of the pond, groundwater had elevated metal concentrations and acidic pH (less than 2). Additional metals found at elevated mean concentrations in Well 318 included aluminum (449 mg/l), beryllium (0.056 mg/l), cadmium (3.19 mg/l), chromium (4.76 mg/l), cobalt (0.087 mg/l), copper (1.00 mg/l), thallium (0.040 mg/l), and zinc (24.2 mg/l).

Mean concentrations of arsenic, boron, lithium, manganese, and selenium for the three wells (Wells 317, 320, and 327) in the downgradient flowpath from the former east overflow pond area exceeded the upper limits for representative wells (Table 4.4-14). Arsenic in these wells ranged from 0.03 to 0.37 mg/l. Boron ranged from

0.17 to 0.61 mg/l, while lithium ranged from 0.06 to 0.25 mg/l. Mean manganese concentrations were 0.001 to 0.444 mg/l, and mean selenium levels were 0.004 to 0.024 mg/l.

Mean concentrations of all common ion parameters except chloride, plus specific conductance and TDS, for groundwater in the former east overflow pond area exceeded representative concentrations (Table 4.4-16). For impacted wells in the former east overflow pond area, mean common ion concentrations were above the upper limit for representative limits for calcium (133 to 367 mg/l), magnesium (49 to 218 mg/l), sodium (84 to 524 mg/l), and sulfate (283 to 1,847 mg/l). For Wells 317 and 320, bicarbonate (1,247 and 477 mg/l) and potassium (19.7 and 26.9 mg/l) concentrations were also elevated. Well 327 had bicarbonate concentrations (348 mg/l) greater than the upper representative limit, but within the range for Portneuf River regime groundwater. Well 318 had the highest potassium concentrations for any well within the Simplot facility (mean of 270 mg/l). Due to the low pH of groundwater from Well 318, no bicarbonate ions were present.

As shown in Table 4.4-16, for the former east overflow pond area of the Simplot facility, the common ion with the greatest increase over representative levels was sulfate. Maximum sulfate concentrations were 3,510 mg/l (mean of 2,703 mg/l) for Well 318 and up to 2,110 mg/l among the other wells.

Specific conductance (up to 7,394 μ mhos/cm) and TDS (up to 12,400 mg/l) were elevated in all wells in the former east overflow pond area. Groundwater in the former east overflow pond area had a pH level lower than representative levels: less than 2 in Well 318, and 5.86 to 6.69 in other wells.

Only Well 318 had elevated gross alpha activities ranging from 984 to 1,690 pCi/l. Wells 317, 318, and 320 had elevated gross beta activities, ranging from 17.59 to 1,163 pCi/l.

Extent and Relationship to Flowpaths of Elevated Constituents in Groundwater beneath the Former East Overflow Pond Area. The former east overflow pond was used to contain Simplot plant process fluids in the event of a plant upset. When this occurred, low-pH process material was pumped into this pond and infiltrated to the groundwater below, as evidenced by the low pH (1.7 to 1.8) observed in Well 318. This low-pH water contained certain metals; in addition, it may have mobilized certain metals present in the soil column beneath the pond area. The buffering capacity of the soils and the bicarbonate groundwater appeared to increase groundwater pH to above 6.0 at a point several hundred feet downgradient from the former east overflow pond. This buffering probably precipitated a large fraction of mobilized metals, while more soluble elements remained in solution in detectable concentrations. The more soluble constituents were nickel and fluoride.

Groundwater flowpaths beneath the former east overflow pond area were influenced by the intersection of flow of groundwater from the gypsum stacks and pumping from the Simplot production wells. Contributions of constituents from the gypsum stacks were augmented by infiltration from the former east overflow pond. At the former east overflow pond, pH was low and many metals not found in groundwater elsewhere were present in groundwater samples collected from Well 318. However, pH increased as groundwater flowed from the former east overflow pond, and the metal concentrations decreased.

Well 317, which is the deeper well paired with 318, had elevated mean concentrations of the following constituents that were found in Well 318: arsenic (0.37 mg/l), boron (0.60 mg/l), calcium (367.18 mg/l), lithium (0.25 mg/l), magnesium (217.77 mg/l), nickel (0.011 mg/l), orthophosphate (103.83 mg/l), potassium (19.67 mg/l), specific conductance (4,594.6 μ mhos/cm), sodium (524.37 mg/l), sulfate (1847.5 mg/l), and total dissolved solids (4,143.3 mg/l). In addition, mean pH (6.01) was below representative levels in the well. Mean alkalinity (bicarbonate) was 1,247.25 mg/l, which was greater than representative levels; however, the mean alkalinity (bicarbonate) in Well 318 was 1 mg/l.

In Well 320, ammonia, arsenic, boron, fluoride, lithium, orthophosphate, nickel, nitrate, total phosphorus, pH and temperature were beyond the range found in representative groundwater. The mean concentrations of ammonia, arsenic, boron, and fluoride in Well 320 were 13.87 mg/l, 0.08 mg/l, 0.42 mg/l, and 5.16 mg/l, respectively. The mean concentrations of lithium, orthophosphate, nickel, nitrate, and total phosphorus in Well 320 were 0.13 mg/l, 37.37 mg/l, 0.098 mg/l, 66.7 mg/l, 34.2 mg/l, respectively. The mean pH in this well was 6.25, and the mean temperature was 18.7°C.

While this well appeared to be downgradient from the former east overflow pond, further evaluation of the hydraulic relationship between it, the former east overflow pond, and other potential sources is being performed as part of the modeling evaluation of influences on groundwater flow patterns. Until this evaluation is completed, the source of the constituents detected in this well cannot be conclusively identified. The results of this evaluation will be presented in the RI report.

4.4.4 Joint Fenceline Area

The joint fenceline area extends from the western third of the Simplot upper gypsum stack northwest to the FMC former kiln scrubber ponds (Figure 4.4-6). The area includes the FMC former calciner ponds, calciner sediment storage area (south of the former calciner ponds), the FMC IWW basin and ditch, and the former kiln scrubber overflow pond. This area also includes the western portion of the Simplot process operations area. The joint fenceline area is discussed separately because

there is a commingling of impacted groundwater, and contributions from individual sources cannot yet be quantified.

4.4.4.1 Overview

The area where the two properties abut is a very complex groundwater mixing area with contributions by both companies. There are several potential sources within the area such as the gypsum stack, former calciner ponds, calciner sediments, the IWW ditch and basin, etc., which complicate this area. It is also further complicated by the subsurface geology, where several different factors control the flow.

The "bedrock low" in this area is controlling flow to some extent through preferential permeability of the fill material within the low (Figure 3.3-12). The flow from this area is generally northwesterly, across the fenceline, perhaps extending as far west as the former kiln scrubber overflow pond. Here it commingles with the northeasterly flow from the FMC operations area, where it meets the flow from the area of the bedrock low. Both these flows are affected by the cone of depression created by Simplot's production wells.

Although the contribution by each company will be investigated through the ongoing analytical modeling study, it is not of great importance because the production wells are controlling the flow of impacted groundwater and there is little migration offsite.

Groundwater underflowing the joint fenceline area is Bannock Range groundwater. Portneuf River Valley and Michaud Flats groundwaters do not underflow this area. The groundwater originates in the Bannock Range recharge areas at higher elevations and flows beneath the joint fenceline area under very high horizontal hydraulic gradients. The high gradients appear to be coincidental with low hydraulic conductivities, indicating that the net groundwater flux through the joint fenceline area is relatively low. Hydraulic conductivities rapidly increase to the north, as the Bannock Range hydrogeologic area transitions to the higher permeability Michaud Flats and Portneuf River hydrogeologic areas. This transition is marked by a corresponding decrease in hydraulic gradient.

A contour map of the top of the Tertiary beds indicates a bedrock low in the area of the joint fenceline area (Figure 3.1-12). Although the Tertiary here defines the "bedrock," it is a series of bedded layers of tuff, rhyolite, and volcanics, which is not an impermeable basement complex as might be inferred by the term bedrock. Although the bedrock low is controlling the groundwater flow in this area, it appears to do so from the preferential permeability of the gravels which fill the channel rather than the lack of percolation capacity of the bedrock.

The mean concentrations of constituents present above representative concentrations in groundwater beneath the upper gypsum stack were: ammonia,

arsenic, bicarbonate, boron, cadmium, calcium, fluoride, lithium, magnesium, manganese, nickel, nitrate, orthophosphate, potassium, reduced pH, selenium, specific conductance, sodium, sulfate, total dissolved solids, total phosphorus, and gross alpha and gross beta. This impacted groundwater flowed northwest beneath the FMC-Simplot fenceline.

As this groundwater underflowed the former calciner ponds, an increase in nitrate, ammonia, chloride, potassium, and zinc was observed. These observations suggest that historic releases from the former calciner ponds were impacting groundwater during the RI sampling period.

Constituents were also contributed to groundwater in the area of the former kiln scrubber overflow pond area, monitored by Well 123. This impacted groundwater migrated northeast and mixed with constituents from other sources.

Most or all of the groundwater that flowed through the joint fenceline area was captured by the Simplot production wells, as illustrated by flowpaths delineated from potentiometric contours in the shallow saturated gravels (Figure 4.4-18).

The overall impacts to deeper groundwater appeared to be minimized by the upward vertical gradients observed throughout most of this area (Figures 3.3-5A to 3.3-5E). In addition, there appears to be a hydraulic separation between shallow and deeper gravels throughout most of this area, as aquitards were observed in most borings.

4.4.4.2 Constituents of Potential Concern in the Joint Fenceline Area

This section describes constituents and potential source areas beginning in the upgradient portion of the joint fenceline area, followed by potential sources located in generally downgradient areas.

Upper Gypsum Stack. A discussion of the characteristics of constituents present in gypsum slurry and solids was provided in Section 4.2.2.1. The mean concentrations of constituents detected in the 12 wells downgradient from the upper gypsum stack, but upgradient from other potential sources in the joint fenceline area, are presented in Tables 4.4-19 through 4.4-22. Wells 304, 307, 308, 309, 312, 323, 324, 331, and 333 are screened in the shallow groundwater zone, while Wells 310, 329, and 330 is screened in the deeper zone. Wells 312, 324, and 331 may also possibly be downgradient from other sources within the joint fenceline area (Figure 4.4-18); further evaluation is in progress.

The mean concentrations of constituents present above representative concentrations in groundwater beneath the upper gypsum stack were: ammonia, arsenic, bicarbonate, boron, cadmium, calcium, fluoride, lithium, magnesium, manganese, nickel, nitrate, orthophosphate, potassium, reduced pH, selenium,

specific conductance, sodium, sulfate, total dissolved solids, total phosphorus, and gross alpha and gross beta. The mean concentrations of ammonia detected in wells associated with the upper gypsum stack ranged from 0.50 mg/l (which is below the representative concentration of 0.80 mg/l) in Wells 304, 309, 310, 323, 324, 329, 330, and 333 to 35.95 mg/l in Well 308. The mean concentrations of arsenic ranged from 0.0038 mg/l (below the representative concentration of 0.032 mg/l) to 0.624 mg/l in Wells 304 and 307, respectively. The mean concentration of arsenic exceeded representative levels in ten wells. However, a decline in arsenic concentrations was observed for several wells in the samples collected in August 1993. In Well 304, arsenic was not detected in the sample collected in August 1993, but was detected at 0.006 mg/l in the sample collected in March 1993. In Well 308, arsenic was detected at a concentration of 0.172 mg/l in the August 1993 sample, and was detected at 0.572 mg/l in the sample collected in March 1993. In Well 312, arsenic was 0.016 mg/l in the August 1993 sample, and was 0.278 mg/l in the sample collected in March 1993.

Alkalinity (bicarbonate) ranged from 156.0 mg/l (below representative) to 1186.8 mg/l in Wells 329 and 307, respectively. Mean boron concentrations ranged from 0.10 mg/l (Well 330), which was below the representative concentration of 0.36 mg/l, to 0.83 mg/l (Well 312). Mean cadmium concentrations exceeded representative levels (0.006 mg/l) only at Well 308, where the mean concentration was 0.015 mg/l. Mean calcium concentrations ranged from 50.2 mg/l (below representative) to 434.5 mg/l in Well 330 and Well 323, respectively. Mean chloride concentrations ranged from 26.0 mg/l (below representative) to 195.5 mg/l in Well 330 and Well 304, respectively.

Mean fluoride concentrations ranged from 0.17 mg/l (below the representative concentration of 0.7 mg/l) in Well 304 to 1.05 mg/l at Well 323; mean fluoride concentrations were below representative levels in eight of the 12 wells monitoring the upper gypsum stack. Mean lithium concentrations exceeded the representative level of 0.062 mg/l in 9 of the 12 wells. Mean lithium concentrations ranged from 0.022 mg/l (Well 304) to 0.616 mg/l in Well 307. The mean concentration of magnesium ranged from 15.8 mg/l in Well 330 to 428.9 mg/l in Well 307; it exceeded its representative level of 42.0 mg/l in 9 of the wells.

Mean manganese concentrations ranged from below its representative level (0.078 mg/l) in Well 330 (0.001 mg/l) to 0.69 mg/l in Well 312. Manganese was noted to exceed representative concentrations in other areas of the EMF study area due to the presence of naturally occurring manganese oxide in the soils. The presence of manganese in the groundwater in this area may also be associated with naturally occurring deposits of manganese oxide.

Mean nickel concentrations slightly exceeded the representative level of 0.01 mg/l in all of the wells. In nine of these wells, mean nickel concentrations were no greater than 0.0116 mg/l. The highest mean concentration was 0.073 mg/l in Well

308. Mean nitrate concentrations ranged from below the representative level of 4.5 mg/l in Well 330 (where it was 0.78 mg/l) to 31.07 mg/l in Well 308. Mean nitrate concentrations exceeded representative levels in 3 of the 12 wells.

The mean concentration of orthophosphate exceeded the representative level of 1.8 mg/l in nine wells, ranging from 0.02 mg/l in Wells 329 and 330 to 164.00 mg/l in Well 323. Mean potassium concentrations ranged from 5.2 mg/l in Well 330 to 50.5 mg/l in Well 309. It exceeded the representative level (13.0 mg/l) in 9 wells.

pH was below the range found in representative groundwater in 6 of the 12 wells monitoring the eastern portion of the upper gypsum stack. As shown in Table 4.4-21, average pH ranged from a low of 5.9 in Well 323 to 7.48 in Well 330. The mean concentration of selenium ranged from 0.0017 mg/l in Well 324 to 0.214 mg/l in Well 312. It exceeded the representative level of 0.007 mg/l in 7 of the 12 wells.

The representative level of specific conductance (1052 μ mhos/cm) was exceeded in 9 wells. The mean levels ranged from 521 μ mhos/cm in Well 330 to 5102 μ mhos/cm in Well 307. Mean sodium concentrations ranged from 32.7 mg/l (below representative) in Well 304 to 613.2 mg/l in Well 307; it exceeded its representative level of 64.0 mg/l in 8 wells.

The mean concentrations of sulfate ranged from 47.0 mg/l in Well 330 to 2,270 mg/l in Well 333. It exceeded the representative level of 79.0 mg/l in 10 of the 12 wells. The mean concentration of total dissolved solids ranged from 350 mg/l in Wells 329 and 330 to 4410 mg/l in Well 307. It exceeded the representative level of 746 mg/l in 9 wells. Mean total phosphorus concentrations ranged from 0.02 mg/l in Wells 329 and 330 to 163.00 mg/l in Well 307. It exceeded the representative level of 3.1 mg/l in 9 of the 12 wells.

Gross alpha and gross beta were also detected at elevated levels in the gypsum stack area. Mean gross alpha activities ranged from nondetected in Well 323 to 192 pCi/l in Well 304. Mean gross beta activities ranged from 6.2 pCi/l in Well 324 to 71.9 pCi/l in Well 304. Radium-226 was detected in Wells 304, 307, 323, and at a maximum value of 3.6 pCi/l in Well 323, comparable to the representative activity of 3.4 pCi/l. Radium-228 activity ranged from not detected in Wells 324, 330, 331, and 333 to a mean of 7.85 pCi/l in Well 304, which exceeded the representative activity.

Higher than representative temperatures were also recorded in groundwater samples collected in Well 309 (19.2 to 19.4°C), Well 310 (19.4 to 19.8 degrees Celsius), and Well 312 (15.6 to 18.7°C). Representative temperatures ranged from 11.4 to 17.9°C.

Shallow Well 324 had lower concentrations of most constituents compared with shallow Well 310 (upgradient of Well 324), and shallow Well 312 (downgradient of

Well 324). Well 324 is located in an area where the silt aquitard between the shallow and deeper gravels is not present. The aquitard was observed at Wells 310 and 312, but it appears to pinch out in the vicinity of Well 324 (Figure 3.1-8). There is a net upward gradient between deep and shallow gravels, as monitored at well pairs 309/310 and 312/329 (Figures 3.3-5A through 3.3-5E). This upward gradient may provide a flux of unimpacted deeper water to Well 324, thereby reducing detected chemical concentrations. The hydraulic interconnection between the shallow and deeper gravels was documented at Well 324 during a pumping test conducted in the new Simplot production Well SWP-7. Persistent upward vertical gradients should reduce the potential for any downward migration of EMF-related constituents in this area. Groundwater in the deeper Wells 309 and 311/329 is comparable with representative Bannock Range groundwater, which provides support to this theory.

Former Kiln Scrubber Overflow Pond, IWW Basin and Ditch, Former Calciner Ponds, Calciner Sediment Storage Area and Former Kiln Scrubber Pond Area. Tables 4.4-19 through 4.4-22 present the mean concentrations for constituents detected in wells monitoring the area of these potential sources; these wells were also downgradient from the western portion of the upper gypsum stack. A description of the characteristics of constituents in these potential sources is presented in Section 4.2.3.1.

The wells associated with this area are Wells 109 (a deep well), 110, 136, 143, 144 (a deep well), 145, 123, and 142. One set of wells (136, 143, 144, and 145) are downgradient of the upper gypsum stack, the former kiln scrubber overflow pond, the IWW basin and ditch, the former calciner ponds, and the calciner sediment storage area. Well 142 is downgradient from the upper gypsum stack and the calciner sediment storage area, but is upgradient or cross-gradient from the former kiln scrubber overflow pond, IWW basin and ditch, and former calciner ponds. Well 123 is downgradient of the former kiln scrubber pond area; the other wells (except Wells 109 and 110) are upgradient from this area. Wells 110 and 109 are paired, and monitor the shallow and deeper groundwater zones along the northern edge of the joint fenceline area (Figure 4.4-18).

The following discussion describes the constituents detected in these sets of wells. The first set consists of Wells 136, 143, 144, and 145. This is followed by a discussion of Well 123 and Well 142. Finally, the constituents detected in Wells 109 and 110 are described.

Wells 136, 143, 144, and 145. A number of constituents were detected in mean concentrations above representative levels in the Wells 136, 143, 144, and 145. Aluminum ranged from not detected to 0.91 mg/l in Well 144. Ammonia was detected at 0.5 mg/l in Well 144 to 12.08 mg/l in Well 145. Arsenic ranged from 0.027 mg/l (below representative) in Well 144 to 0.52 mg/l in Well 136. However, a decline in arsenic concentrations was observed for several wells in the samples collected in July and August 1993. In Well 136, arsenic was detected at 0.04 mg/l in

August 1993, but was 0.42 mg/l in the sample collected in March 1993. In Well 143, arsenic was 0.04 mg/l in the August 1993 sample, and was 0.35 mg/l in the sample collected in March 1993. In Well 144, arsenic was not detected in the August sample, but was 0.002 mg/l in March 1993. In Well 145, arsenic was 0.04 mg/l in the August 1993 sample, and was 0.39 mg/l in the sample collected in March 1993.

Boron was present between 0.43 mg/l in Well 144 to 1.19 mg/l in Well 143. Cadmium was present slightly above its representative level at 0.0064 mg/l in Well 143. Copper was also slightly above its representative level at 0.025 mg/l in Well 145. Fluoride ranged from 0.39 mg/l (below representative) in Well 143 to 1.50 mg/l in Well 136. Lithium ranged from 0.09 mg/l in Well 144 to 0.50 mg/l in Well 136.

Manganese ranged between 0.21 mg/l in Well 144 and 2.18 mg/l in Well 136. Manganese was noted to exceed representative concentrations in other areas of the EMF study area due to the presence of naturally occurring manganese oxide in the soils; the presence of manganese in the groundwater in this area may also be associated with naturally occurring deposits of manganese oxide.

Nickel ranged from not detected (below representative) in Well 144 to 0.06 mg/l in Well 143. Nitrate was detected between 2.65 mg/l (below representative) in Well 136 to 7.35 mg/l in Well 143. Orthophosphate ranged from 0.44 mg/l (below representative) in Well 144 to 113.00 mg/l in Well 136. Selenium was detected between 0.017 mg/l (below representative) in Well 144 to 0.148 mg/l in Well 143. Total phosphorus ranged from 1.24 mg/l (below representative) in Well 144 to 114.00 mg/l in Well 136. Vanadium was detected at a mean concentration slightly above representative in Well 143 at 0.13 mg/l; it was below representative levels in other wells.

In addition, mean pH was lower than the range found in representative groundwater in Wells 136, 143, and 145. Among these wells, mean pH ranged from 6.09 in Well 136 to 6.22 in Well 143. Mean specific conductance ranged from 1,709 μ mhos/cm in Well 144 to 4,982 μ mhos/cm in Well 136. Mean total dissolved solids ranged from 1,292 mg/l in Well 144 to 4,170 mg/l in Well 136. Redox exceeded representative levels in Wells 144 and 145, where single measurements were 442 and 312 millivolts, respectively. Alkalinity (bicarbonate) ranged from 396.4 mg/l in Well 144 to 1,155.0 mg/l in Well 136.

Calcium ranged from 218.2 mg/l in Well 144 to 409.4 mg/l in Well 143. Chloride ranged from 149.2 mg/l (below representative) in Well 144 to 305.8 mg/l in Well 143. Magnesium ranged from 72.1 mg/l in Well 144 to 290.7 mg/l in Well 136. Potassium ranged from 16.6 mg/l in Well 144 to 122.1 mg/l in Well 143. Sodium ranged from 86.6 mg/l in Well 144 to 695.7 mg/l in Well 136. Sulfate ranged from 128.2 mg/l in Well 109 to 1,784.8 mg/l in Well 136.

Mean gross alpha activities ranged from 5.7 pCi/l in Well 143 to 20.4 pCi/l in Well 144. Mean gross beta activities ranged from 23.8 pCi/l in Well 143 to 64.3 pCi/l in Well 145. Radium-226 ranged from nondetected in Well 136 to 2.5 pCi/l in Well 143, which was below the representative activity. Radium-228 activity ranged from not detected in Wells 143 and 145 to 12.9 pCi/l in Well 144, which exceeded the representative activity.

Well 123. Well 123, downgradient of the former kiln scrubber pond area, contained the following mean constituent concentrations above representative levels: alkalinity (bicarbonate) 692.0 mg/l, ammonia (4.38 mg/l), arsenic (0.55 mg/l), boron (0.99 mg/l), calcium (339.0 mg/l), chloride (364.0 mg/l), lithium (0.24 mg/l), magnesium (157.0 mg/l), manganese (0.45 mg/l), nickel (0.011 mg/l), nitrate (10.83 mg/l), orthophosphate (4.86 mg/l), potassium (30.0 mg/l), reduced pH (5.95 to 6.26), selenium (0.34 mg/l), sodium (249.0 mg/l), specific conductance (3,647 μ mhos/cm), sulfate (924.0 mg/l), total dissolved solids (2,856 mg/l), total phosphorus (5.12 mg/l), and vanadium (0.18 mg/l).

The mean gross alpha and beta activities in Well 123 were 3.9 pCi/l (within representative) and 26.8 pCi/l, respectively. Radium-226 and radium-228 were not detected.

Well 142. Well 142, downgradient of the upper gypsum stack and the calciner sediment storage area, contained the following mean constituent concentrations above representative levels: alkalinity (bicarbonate) (933.0 mg/l), calcium (398.0 mg/l), magnesium (125.0 mg/l), potassium (18.0 mg/l), reduced pH (6.43 to 6.68), selenium (0.009 mg/l), sodium (125.0 mg/l), specific conductance (2,558 μ mhos/cm), sulfate (1,004.0 mg/l), total dissolved solids (2,682 mg/l).

The mean gross alpha and gross beta activities in Well 142 were 30.5 pCi/l and 21.8 pCi/l, respectively, exceeding the representative activities. Radium-226 was detected at 2.7 pCi/l and radium-228 at 1.1 pCi/l.

Wells 109 and 110. No metals were present above representative levels in Well 109; however, the mean fluoride concentration (0.89 mg/l) in this well slightly exceeded the representative level. The follow constituents were present in mean concentrations above representative levels in Well 110: arsenic (0.11 mg/l); boron (0.79 mg/l); calcium (213.4 mg/l); lithium (0.14 mg/l); magnesium (87.9 mg/l); manganese (0.14 mg/l); orthophosphate (4.81 mg/l); potassium (17.0 mg/l); selenium (0.05 mg/l); sodium (165.4 mg/l); sulfate (627.9 mg/l); and total phosphorus (16.24 mg/l).

In addition, mean pH in Well 110 (6.40) was lower than the range found in representative groundwater. The mean specific conductance (2,382 μ mhos/cm), total dissolved solids (1783 mg/l), and alkalinity (bicarbonate) (556.8 mg/l) were also above representative levels in Well 110.

The mean gross alpha activities ranged from 5.0 pCi/l (Wells 109) to 11.8 pCi/l (Well 110), while gross beta ranged from 9.0 pCi/l (Well 109) to 23.3 pCi/l (Well 110). Radium-226 and radium-228 were detected at 3.8 pCi/l and 3.0 pCi/l in Well 109. In Well 110, radium-226 was not detected and radium-228 was detected at 6.0 pCi/l.

General comparison. The wells downgradient from the upper gypsum stack were compared with the wells downgradient from both this upper gypsum stack and the additional potential sources to evaluate whether constituent levels in groundwater might have been enriched by these additional potential sources. In this comparison, the maximum mean concentration of a constituent found in the wells associated with the upper gypsum stack were compared with the maximum concentration from among the other wells. This comparison found that 11 constituents were present in greater mean concentrations in wells downgradient from both groups of potential sources in the joint fence line area, compared with wells downgradient from only the upper gypsum stack. However, as described below, four constituents are not believed to be site-related.

Aluminum was present at a maximum mean concentration of 0.9 mg/l in Well 144 compared with 0.7 mg/l in Well 323 associated with the upper gypsum stack. As found in other wells, aluminum levels are believed to be associated with suspended silt in the well, and are not indicative of site-related impacts. Consequently, the presence of aluminum is not considered significant.

Boron was present at a maximum mean concentration of 1.19 mg/l in Well 143 compared with 0.74 mg/l in Well 307 associated with the upper gypsum stack. Chloride was detected at a maximum mean concentration of 305.8 and 364.0 mg/l in Wells 143 and 123, respectively compared with 195.0 mg/l in Well 304 associated with the upper gypsum stack. Copper was present at a maximum mean concentration of 0.025 mg/l in Well 145 compared with 0.01 mg/l (below representative) in Well 312 associated with the upper gypsum stack. The concentration of copper in representative groundwater (0.022 mg/l) is slightly below the level found in Well 145, and the presence of copper in this well is likely not site-related.

The maximum mean fluoride concentration (1.5 mg/l in Well 136) was greater than the maximum mean fluoride concentration (1.3 mg/l in Well 308) in a well associated with the upper gypsum stack. Manganese was present at a maximum mean concentration of 2.1 mg/l in Well 136 compared with 0.69 mg/l (below representative) in Well 312 associated with the upper gypsum stack. However, as discussed previously, elevated concentrations of manganese in groundwater above representative levels are believed to be naturally occurring. Thus, the presence of manganese in Well 136 may not be indicative of a site-related impact.

Potassium was present at a maximum mean concentration of 122.1 mg/l in Well 136 compared with 50.5 mg/l in Well 309 associated with the upper gypsum stack.

Selenium was present at a maximum mean concentration of 0.34 mg/l in Well 123 compared with 0.21 mg/l in Well 312 associated with the upper gypsum stack. Sodium was present at a maximum mean concentration of 695.7 mg/l in Well 136 compared with 613.2 mg/l in Well 307.

Vanadium was detected at a maximum mean concentration of 0.18 mg/l in Well 123 compared with 0.03 mg/l in Well 312. Zinc was 0.059 mg/l (below representative) in Well 142 compared with 0.027 mg/l (below representative) in Well 308. Thus, like aluminum, copper, and manganese, zinc is not believed to reflect a site-related impact.

4.4.4.3 Extent of Constituents in the Joint Fenceline Area

The southern extent of EMF-related constituents is delineated by Wells 301 and PEI-1, located along the southern margin of the upper gypsum stack. The mean concentrations of constituents in these wells were within the range found in representative groundwater.

Data indicate that arsenic from the sources in the joint fenceline area is not migrating northward from the point where the joint fenceline meets the northern boundary fenceline, near Well 110. Throughout the joint fenceline area, mean arsenic concentrations ranged from approximately 0.02 to 0.6 mg/l. The highest concentrations were detected in wells immediately adjacent to the upper gypsum stack, located upgradient from other potential sources in the area, while the lowest concentrations were detected in Well 324. At Wells 307 and 308, immediately downgradient of the upper gypsum stack, mean arsenic concentrations were 0.53 and 0.57 mg/l, respectively.

At Wells 136 and 145, downgradient of the former calciner ponds, mean arsenic concentrations were 0.42 and 0.40 mg/l, respectively. This is a decline of approximately 0.1 to 0.17 mg/l within less than 1,000 feet. Concentrations decreased further at Wells 312 and 331 further downgradient to levels of 0.2 to 0.3 mg/l. Further north, at offsite Well 517, arsenic was present within representative levels (0.033 mg/l).

Sulfate can also be useful in delineating the extent of potential impacts. Well 142 is located west of the upper gypsum stack and upgradient from the former calciner ponds. This well did not contain metals, nutrients, or fluoride above the representative levels. However, sulfate and calcium were detected above Bannock Range groundwater representative levels. The occurrence of sulfate and calcium is indicative of gypsum stack effects; the lack of arsenic and other constituents of potential concern indicates that the gypsum stack effects did not extend much further west of Well 142.

The Simplot production wells controlled the northern and eastern extent of constituents emanating from the sources located in the joint fenceline area. These wells had a measurable cone of depression in the shallow groundwater, and the capture zone delineated from potentiometric contours indicates these wells captured most of the groundwater flowing through the joint fenceline area. The production well capture zones extended to the vicinity of Wells 517 and TW-12S. This effectively eliminated the potential migration of constituents to the north and east.

4.4.5 Characterization of Groundwater Quality in Offsite Areas

EMF-related constituents were delineated in the groundwater beyond the FMC and Simplot fencelines during the RI. The area impacted by EMF activities lies to the north of the facilities, and is bounded by Wells 514, 515, 516, 502, and TW-11S to the north of I-86 (Figure 4.4-6). EMF-related constituents were not elevated above representative levels in groundwater samples analyzed from these wells. In addition, EMF-related constituents were not detected above representative levels in Wells 520, 322, 506/507, and 508/509 located along the Portneuf River.

The EMF-related constituents arsenic, fluoride, orthophosphate, total phosphorus, and sulfate were detected at low concentrations in Wells 517, 518, TW-9S, Old Pilot House, Frontier, 503, 505, and TW-12S. In addition, there appeared to be an EMF-related influence at Batiste Spring and Swanson Road Spring (Figures 4.4-1 through 4.4-5).

There are two important observations related to the nature and extent of constituents in offsite groundwater. First, the concentrations of all EMF-related constituents were 10 to 100 times lower in impacted offsite groundwater, when compared with the levels of these constituents detected in onsite wells (Figures 4.4-1 through 4.4-4). In many cases, the concentrations of EMF-related constituents were close to or below representative levels, indicating rapid attenuation or very large mixing ratios with other groundwater. Second, the available historical data indicate that offsite groundwater concentrations have decreased rapidly in response to changes in material handling practices at the EMF facilities. For example, arsenic concentrations in the Old Pilot House well and Well TW-9S decreased shortly after FMC closed a group of former ponds. Additional closures of waste management units at both FMC and Simplot have occurred since collection of the latest group of samples reported in this document. These changes should contribute further toward improved groundwater quality.

EMF-related constituents detected in offsite groundwater were limited to the upper saturated levels, with a localized occurrence of deeper impacted groundwater at the Frontier well. Throughout the area of impacted offsite groundwater, strong upward vertical hydraulic gradients were observed (Figures 3.3-5A to 3.3-5E). These upward hydraulic gradients limit downward migration of impacted groundwater, and it is

thought that the limited impacted deeper groundwater at the Frontier well may be associated with pumping the well, which would decrease the upward gradient, and may locally reverse vertical gradients. This well may have been installed with an insufficient sanitary seal, thus providing a conduit for infiltration down the annular space. Upward vertical gradients are observed near the Simplot production wells, further indicating that the effects of pumping in the deeper gravels has a very localized effect on vertical gradients.

4.4.5.1 Nature of Site-Related Constituents in Offsite Groundwater

The following provides a description of the constituents detected in wells located beyond the FMC and Simplot facility fenceline. Results of all sample analyses from offsite wells sampled during the RI are presented in Appendix H. These analytical results were evaluated to identify:

- Constituents whose concentrations occur at levels at or below the representative levels defined in Section 4.4.1, or constituents that were sporadically detected at or near their detection limit. These were eliminated from further consideration.
- Constituents that are present above representative levels or that can identify EMF-related impacts to groundwater offsite.

Although certain onsite impacts can be spatially and chemically correlated with EMF facilities activities, a detailed understanding of groundwater flow and transport is currently lacking for much of the offsite area. Conclusions regarding potential sources and flowpaths are preliminary and subject to change as the results of groundwater flow modeling become available.

EMF-related constituents were identified in offsite wells through analyses of common ions and characteristic constituents. These sampling locations are Wells 503, 505, 517, 518, TW-9S, TW-12S, Frontier, and Old Pilot House. In addition, Batiste Spring and Swanson Road Spring, where groundwater discharges to surface water, have elevated levels of certain EMF facilities-related constituents.

With the exception of the Frontier well, all of the wells identified above are screened in the uppermost saturated zone. None of the other 10 offsite wells screened in deeper water-bearing zones contained elevated concentrations of any EMF facilities-related constituents.

Constituents That Were Eliminated. As described in Section 4.4.1, six constituents were eliminated from consideration through comparisons of their concentrations with representative concentrations and frequency of occurrence. These constituents were antimony, lead, molybdenum, silver, barium, and mercury. In addition,

cadmium, chromium, aluminum, iron, manganese, and vanadium were eliminated for the following reasons.

Cadmium occurred at a maximum concentration of 0.008 mg/l and a mean of 0.002 mg/l in offsite impacted wells. The upper limit for representative levels was 0.006 mg/l. However, only one sample was above the representative level, and this value was the 0.008 mg/l just mentioned that was collected from Well TW-12S. The validation process assigned a "J" qualifier (meaning this is an estimated value) to this result due to poor matrix spike performance and poor instrument quality control. Consequently, this value is likely an artifact of laboratory analysis. Cadmium was not detected above representative levels in any of the previous RI sampling events. Based on the above considerations, cadmium was eliminated from further consideration (Table 4.4-23).

Chromium did not occur at levels exceeding representative groundwater concentrations. The mean concentration of chromium detected in offsite impacted wells is 0.001 mg/l with a maximum concentration of 0.002 mg/l. Chromium was eliminated from further consideration (Table 4.4-23).

Aluminum was eliminated because the maximum concentration detected in impacted wells was 0.08 mg/l, well below the representative level. Iron was also eliminated. Although the maximum value in a single sample (2.73 mg/l) was above the representative value, the mean concentration was less than half the representative value (Table 4.4-23). The highest concentrations of iron in offsite impacted wells occurred in those wells with mild steel casing.

Manganese was detected at a maximum concentration of 1.21 mg/l in Well TW-9S, which consistently contained the highest offsite manganese concentrations. The Old Pilot House well also had consistently high manganese concentrations, approximately 1.0 mg/l. Both wells lie along the groundwater flowpath of the naturally occurring manganese originating at FMC near Well 151. Representative manganese levels are 0.078 mg/l (Table 4.4-24 and Figure 4.4-24). Thus, it was concluded that manganese is not a site-related constituent.

Vanadium occurred only in Well TW-9S at a concentration of 0.14 mg/l. Subsequent sampling and analysis resulted in a reported concentration of 0.002 mg/l. Other impacted wells contained vanadium at concentrations below the representative level (Table 4.4-24).

Constituents Associated with EMF Site-Related Activities. The constituents detected at concentrations above representative levels in the impacted offsite wells were ammonia, arsenic, fluoride, lithium, nickel, nitrate, orthophosphate, selenium, and total phosphorus. These constituents were not detected at elevated levels in every impacted well. Concentration ranges and means for all these

constituents are summarized in Tables 4.4-24 and 4.4-25. Representative concentrations are included in this table for comparison.

These constituents were previously identified as characteristic constituents in the analysis of groundwater quality beneath the FMC and Simplot facilities. Major ion concentrations for Wells 505, TW-12S, Frontier, Batiste Spring, TW-9S, and Old Pilot House did not appear significantly elevated, especially when compared with impacted wells adjacent to source areas. However, major ion concentrations were elevated in Wells 503, 517, and 518, as shown in Figure 4.4-25.

Groundwater from Wells TW-9S, Old Pilot House, and TW-12S contained the highest concentrations of arsenic for any of the offsite wells tested during the RI (up to 0.050 mg/l was reported during one monitoring event at TW-12S and Old Pilot House). Other wells with arsenic concentrations above the mean representative concentration included Wells 503, 517, and 518, with detected concentrations ranging from 0.015 mg/l to 0.033 mg/l. The upper range of arsenic concentration in representative groundwater was 0.032 mg/l (Figure 4.4-26).

Selenium was reported at maximum concentrations of 0.018 and 0.019 mg/l in Wells TW-12S and 517, respectively. This concentration is approximately 0.012 mg/l higher than the representative concentration. With the exception of one sampling event at Batiste Spring (December 1992 at 0.010 mg/l), concentrations from all other wells were at or below the representative concentration (Figure 4.4-27).

Wells 517, TW-9S, TW-12S, and Old Pilot House contained elevated lithium, detected at maximum concentrations from 0.09 to 0.104 mg/l; the representative concentration was 0.062 mg/l.

Total phosphorus and orthophosphate were also EMF site-related constituents that occurred in the impacted wells. Total phosphorus was detected in the offsite impacted wells at concentrations ranging from 3.56 mg/l to 28 mg/l (Figure 4.4-5). Orthophosphate was detected in these wells at concentrations ranging from 2.38 mg/l to 26.8 mg/l (Figure 4.4-2). The overall concentrations were significantly lower than the maximum concentrations detected in onsite wells immediately adjacent to potential sources. While mean concentrations were relatively low, Wells TW-9S, TW-12S, and Old Pilot House contained higher than representative concentrations of these constituents. The mean concentrations of total phosphorus detected at Well TW-9S, TW-12S, and Old Pilot House were 3.01, 31.9, and 7.41 mg/l, respectively. The mean concentrations of orthophosphate in these wells were 2.86, 29.6, and 5.85 mg/l, respectively.

Fluoride was also identified as an EMF site-related constituent detected in offsite groundwater. Three wells (320, 503, and TW-12S) contained elevated concentrations of fluoride relative to representative concentrations. However, fluoride

concentrations in these wells did not exceed 1.3 mg/l, while representative fluoride concentrations were 1.0 mg/l in Bannock Range groundwater (Figure 4.4-28).

Sulfate was used as a characteristic constituent to delineate EMF facilities impacts in onsite groundwater. Elevated sulfate concentrations were associated with most of the EMF onsite potential sources (Figure 4.4-4). Representative concentrations of sulfate were approximately 79 mg/l. The offsite impacted wells contained sulfate concentrations ranging from 61 mg/l in Well 505 to a maximum concentration of 574 mg/l in Well TW-12S.

The oxidizing nature of the groundwater in the study area should not reduce sulfate to sulfides, thereby making sulfate a conservative tracer in the groundwater. Some precipitation of sulfate minerals may occur immediately beneath the source areas if there is supersaturation with respect to certain sulfate minerals, but when sulfate concentrations decrease away from these potential sources, the conservative tracer assumption appears valid. Sulfate was found at concentrations ranging from 230 mg/l up to 614 mg/l near the FMC former pond area, and at concentrations of approximately 1,900 mg/l near the Simplot gypsum stacks.

Nitrate was detected at concentrations exceeding representative levels in Wells TW-12S, Old Pilot House, and TW-9S. These wells contained nitrate at concentrations ranging from 7 to 33 mg/l. Ammonia was detected in Well 503 at concentrations up to 3.4 mg/l. Preliminary findings suggest that the occurrence of ammonia may be associated with the gypsum stack and former calciner ponds. Nitrate in the impacted wells may have been an oxidation product of this ammonia. Nitrate detected in unimpacted wells occurred as a result of non-EMF-related anthropogenic activities; representative nitrate concentrations ranged up to 4.5 mg/l.

4.4.5.2 Extent of EMF Site-Related Constituents in Offsite Groundwater

The following discussion focuses on the distribution of arsenic, orthophosphate, total phosphorus, fluoride, nickel, sulfate, and pH in offsite groundwater. Arsenic is discussed because it was identified as a site-related constituent and it occurs at elevated levels in several offsite wells and Batiste Spring. The distribution of phosphorus and orthophosphate is considered here because these are EMF site-related constituents. Fluoride and nickel are site-related constituents primarily associated with the former east overflow pond. These elements were probably mobilized as a result of low-pH water that was temporarily held in this pond. pH was used as a tracer from Well 318, associated with the former east overflow pond.

Sulfate appears useful to assess the extent of impact. When sulfate is introduced into groundwater, it rapidly reaches equilibrium. It does not tend to react with other ions and does not precipitate as a mineral. This is especially true for groundwater with oxidizing Eh conditions, which is common for groundwater beneath the EMF.

facilities. The sulfate emanating from the southwest sector of FMC crossed the FMC fenceline near Wells 111 and 146. By the time groundwater reached this area, sulfate concentrations had decreased by several hundred mg/l from the source areas. Further reductions in concentrations would be expected as the groundwater continues flowing offsite toward the Old Pilot House and TW-9S wells. The sulfate originating from the gypsum stack area and potential sources in the eastern FMC area may have mixed with the southwest FMC plume; however, most of this groundwater was apparently captured by the Simplot production wells.

Sulfate concentrations in Batiste Spring and Wells 503, 518, and 517 were greater than the surface concentrations at Wells 111, TW-9S, and Old Pilot House. This indicates additional sulfate sources were adding to the sulfate concentrations detected in offsite wells and springs.

The pattern in the extent of constituents is generally consistent. Wells 503, TW-9S, Old Pilot House, TW-12S, and 517 appeared to contain the highest levels of site-related constituents. Well 518, Swanson Road Spring, and Batiste Spring contained elevated concentrations of certain constituents, but at lower concentrations than the wells listed above. Figures 4.4-1 through 4.4-5 illustrate the overall extent of sulfate, orthophosphate, total phosphorus, pH, and arsenic. Sulfate was plotted to illustrate spatial correlations with sources and elevated sulfate in groundwater. These correlations can be related to preliminary characterization of groundwater flowpaths.

Orthophosphate and total phosphorus show nearly identical distributions in offsite groundwater, and, when compared with sulfate, there appears to be a relatively consistent spatial pattern for EMF site-related constituents. These two constituents appeared to be emanating from the southwestern area of FMC and the Simplot source areas. Arsenic concentrations also appeared to follow the same general trends as other constituents.

Nickel is associated only with the low-pH releases from the former east overflow pond. This association provides a characteristic constituent related to a specific source. The distribution of elevated nickel concentrations was isolated to areas east and north of the Simplot production wells.

Constituents associated with EMF activities were detected offsite at elevated concentrations in Wells 503, 505, 517, 518, TW-9S, TW-12S, Frontier, Old Pilot House, Batiste Spring, and Swanson Road Spring (Figure 4.4-28). The lateral extent of elevated concentrations is delineated by Wells 502 and 516 to the north, Wells 520 and 506 to the east, and the Portneuf River to the northeast. There was no evidence that impacted groundwater extended offsite to the north of FMC near Wells 112 and 501. Wells 514, 515, 516, and 502 are all located north of I-86. Groundwater samples collected and analyzed from these wells did not indicate any EMF site-related impacts.

Section 4 Nature and Extent of Constituents of Potential Concern

Ten deeper wells do not contain elevated concentrations of site-related constituents; therefore, the vertical extent of these constituents appeared to be limited to the shallow groundwater in offsite areas. Monitoring Wells 512, 513, 508, 509, 511, and 510 are all located on the northwestern side of the Portneuf River. None of these wells were impacted by EMF site-related constituents. The upward vertical hydraulic gradients throughout large portions of the EMF study area appeared to limit downward vertical migration of the dissolved constituents. Localized elevated concentrations were detected in the deeper Frontier well. However, the past operation of this well may have induced some local downward migration, especially if this well was not installed with a proper sanitary seal.

Section 4.5

4.5 SURFACE WATER AND SURFACE WATER SEDIMENTS

This section characterizes the types and distribution of constituents of potential concern in surface water and sediments in the Portneuf River and related springs. It identifies those constituents introduced from the EMF facilities' operations. The discussion is based on the following:

- Phase I and Phase II RI sampling and analysis data
- Previous investigations conducted in the EMF study area
- Record reviews conducted at the Simplot and FMC facilities

Interpretation of the data was aided by the use of the conceptual framework describing the surface water characteristics, associated sediment deposition patterns, and drainage patterns in the EMF study area, as discussed in Section 3.2.

An overview of the primary findings pertinent to surface water and sediment quality characteristics in the EMF study area is presented on page 4.5-3. It also shows the format and organization of Section 4.5. This section is organized as follows:

- Potential sources of constituents of concern and associated migration pathways are discussed in Section 4.5.1.
- Surface water quality investigations are discussed in Section 4.5.2.
- The quality of springs and river sediments as affected by EMF facilities operations, is discussed in Section 4.5.3.

Investigations conducted in the EMF study area resulted in the identification of one potential onsite source (the FMC industrial wastewater outfall), and offsite potential sources such as the Pocatello Sewage Treatment Plant (STP), Batiste Springs Fish Farm, Papoose Springs Fish Farm, nonpoint source agricultural runoff, sewage and stormwater discharges in the Pocatello areas, and NPL sites upstream from the EMF facilities. These are identified and discussed in Section 4.5.1.

Section 4.5.2 presents analyses of data gathered during the RI and draws preliminary conclusions as to the potential effects of EMF facilities operations on surface water quality. In summary, these are as follows:

- Groundwater from the EMF operations area cannot contaminate the Portneuf River upstream of the I-86 bridge due to river/groundwater system characteristics.
- Offsite sources (such as the Pocatello STP and the fish farms) have impacted the Portneuf River water quality.

Section 4 Nature and Extent of Constituents of Potential Concern

- Site-related constituents consisting of the metals arsenic and lithium (only at Batiste Spring); the common ion sulfate; and the nutrients nitrate, orthophosphate, and total phosphorus were found in water samples from Batiste Spring and Swanson Road Spring. However, site constituents were not found in the river below the spring discharge points into the river.
- Elevated levels of site-related constituents were detected in samples collected during one of the three sampling events conducted at the IWW ditch. These constituents were not detected in the samples collected during the two later events. Consequently, the elevated levels may be related to some episodic release that appears to have ceased. The impact of this release on ambient water quality is thus limited.

Sediment deposition patterns at the Portneuf River, along with the potential sources of river sediments, are briefly summarized in Section 4.5.3. Section 4.5.3 also presents the results of the RI data, and draws the following preliminary conclusions:

- There is no footprint of EMF site-related constituents in sediments along the Portneuf River between site discharges and the Fort Hall Bottoms. Site constituents, readily recognized by a set of characteristic constituents (cadmium, fluoride, vanadium, zinc, and phosphates), are present in sediment only at the mouth of the FMC outfall.
- Other sources of constituents (i.e., Pocatello STP, fish farms) impact the Portneuf River sediment quality.

The RI surface water and sediment sampling results are presented in Appendix E.

4.5.1 Potential Sources of Discharge and Migration Pathways to Surface Water

Potential discharges of site-related constituents into surface waters (and sediments) in the EMF study area were evaluated by sampling various locations at the Portneuf River and springs and associated spring drainage channels during the Phase I and Phase II RI. With the exception of three sediment samples taken in the Fort Hall Bottoms, sampling locations ranged from the City of Pocatello (approximately 6 miles [9.6 km] upstream of the EMF facilities), to river mile 10 (see Figure 2.5-1). All samples were analyzed for a suite of metal, nutrient, common ion, and radiological parameters, as identified in Section 2.5.

Overview of Section 4.5 Surface Water and Surface Water Sediments

| | Surface Water | | Surface Water Sediments | |
|--|---|--|--|--|
| | <i>Section 4.5.1</i> | | <i>Section 4.5.1, 4.5.3.1</i> | |
| Potential Sources of Constituents: | <ul style="list-style-type: none"> ■ Current outfalls ■ STP ■ Former outfalls ■ Redeposition from upstream ■ Fish farms ■ Groundwater ■ Erosion ■ Windblown deposition ■ Overland flow ■ Creamery operations ■ Pocatello industries ■ Nonpoint sources | | <ul style="list-style-type: none"> ■ Current outfalls ■ STP ■ Former outfalls ■ Redeposition from upstream ■ Fish farms ■ Groundwater ■ Erosion ■ Windblown deposition ■ Overland flow ■ Creamery operations ■ Pocatello industries ■ Nonpoint sources | |
| Sampling Locations: | <div style="border: 1px solid black; padding: 5px; text-align: center;"> Portneuf River Springs Sediments </div> | | | |
| Site-related Constituents Found in Samples: | <div style="text-align: center;">↓</div> <i>Section 4.5.2</i> <ul style="list-style-type: none"> ■ Sulfate and arsenic, etc. detected immediately below FMC outfall during Phase I ■ Not detected downstream ■ Constituent discharge from FMC outfall not elevated in Phase II sampling | <div style="text-align: center;">↓</div> <i>Section 4.5.2</i> <ul style="list-style-type: none"> ■ A portion of the arsenic, sulfate, total phosphorus, and other constituents detected at Batiste and Swanson Road springs may be attributed to releases from the EMF facilities | <div style="text-align: center;">↓</div> <i>Section 4.5.3</i> <ul style="list-style-type: none"> ■ Phosphate ore and precipitator dust detected below FMC outfall ■ Not found in downstream sediments at levels associated with source characteristic constituents | |
| Conclusions: | <ul style="list-style-type: none"> ■ Groundwater from the EMF operations area cannot contaminate the Portneuf River upstream of the I-86 bridge due to river/groundwater system characteristics. ■ Site-related constituents were found in water samples from Batiste Spring and Swanson Road Spring. These include arsenic, sulfate, lithium, boron, and total phosphorus. ■ Site constituents present in Batiste Spring and Swanson Road Spring were not found in the Portneuf River below the discharge points of these springs into the river. ■ There is no footprint of constituents in sediments along the Portneuf River between the site and the Fort Hall Bottoms. Site constituents readily recognized by a set of characteristic constituents (Cd, F, V, Zn, P-total), are present only at the mouth of the FMC outfall. ■ Other sources of constituents (fish farm, STP) and upstream discharges impact Portneuf River and sediment quality. ■ Discharge of constituents from the IWW ditch was limited to one out of three sampling events. | | | |

In conjunction with the information gathered from EMF facility records and from previous investigations, several onsite and offsite potential sources (and migration pathways) were identified as possibly having contributed site-related constituents to surface water and, in one case, to the sediments, in the EMF study area. These are summarized in Section 4.5.1.1, and detailed in Sections 4.5.2 through 4.5.5. Potential sources of site-related constituents to sediments are also examined and discussed in Section 4.5.3.

4.5.1.1 Summary of Potential Sources and Migration Pathways

The investigation of potential sources (see Section 4.2) and groundwater (see Section 4.4) identified the following pathways that may discharge site-related constituents to surface water and, in some cases, sediments in the EMF study area:

- Groundwater
- FMC outfall
- Air deposition
- Overland runoff of impacted soils

Impacted groundwater is present beneath the EMF operations areas. A portion of the groundwater that flows from the EMF facilities operations areas discharges to the surface at Swanson Road Spring (spring sampling station SW/SD15) and Batiste Spring (spring sampling station SW/SD14). The FMC outfall is a permitted discharge to surface water. Noncontact cooling water is conveyed to the outfall from the IWW basin via the IWW ditch. River sampling station SW/SD17 is downstream of the FMC outfall.

Air deposition of site-related constituents from the EMF facilities does not appear to be a migration pathway to surface waters and sediments. Should surficial deposition be occurring, it is occurring at a rate that is not measurable, given the surface area and flowrate of the Portneuf River water. In addition, based on the discussion in Section 3.2, discharge of constituents as a result of overland runoff of impacted soils from the EMF facilities does not occur even during the most extreme storm conditions.

Several potential sources, not related to the EMF facilities, exist along the Portneuf River downstream from the EMF facilities. These potential sources include the following:

- Pocatello STP
- Fish farm along the Batiste Springs drainage channel (Batiste Springs Fish Farm)

- Fish farm along the Papoose Springs drainage channel (Papoose Springs Fish Farm)
- Agricultural return water
- Nonpoint source agricultural runoff

In fact, due to the discharge of raw sewage into the Portneuf River and resulting high E-coli content, use of the river for contact recreational sports is discouraged by the State of Idaho. The raw sewage is discharged from private outfalls upstream from the EMF facilities in the City of Pocatello. The Southeastern District Health Department has issued year-round advisories regarding use of the river due to these discharges for the past 4 years (Low, 1993).

Upstream of the EMF facilities, potential sources include:

- CERCLA sites
- Miscellaneous light industrial activity in Pocatello
- Stormwater discharge in Pocatello
- Sewage discharge in Pocatello
- Nonpoint source agricultural runoff
- Agricultural return water

On the basis of the RI, it was determined that the upstream potential sources have impacted Portneuf River surface water and sediment quality above the EMF facilities operations area (see Sections 4.5.2 and 4.5.3). These sources are not individually addressed in the PSCS.

4.5.1.2 Impacted Groundwater

Impacted groundwater between the boundaries of the EMF facilities and the Portneuf River is discussed in detail in Section 4.4. Figures 4.4x-1 through 4.4x-4 show areas of impacted groundwater north and east of the facilities' fencelines in the vicinity of the river. Arsenic concentrations in groundwater decrease from enriched concentrations within the EMF operations areas to near-representative groundwater levels in wells adjacent to the Portneuf River. Sulfate and total phosphorus concentrations in groundwater are at concentrations above representative groundwater levels in several wells (Wells 503, 504, and 505) near the southwest bank of the Portneuf River. Manganese and lithium concentrations are also above representative groundwater levels in wells near the left bank of the Portneuf River. In this section, "left bank" designates the bank on one's left side

when facing downstream, and "right bank" refers to the opposite side of the Portneuf River. This follows standard convention.

Batiste Spring (SW14) and Swanson Road Spring (SW15) have water chemistry and/or elevated levels of nutrients or metals which indicate a discharge of groundwater bearing EMF facilities-related parameters. Additionally, the Portneuf River is a gaining stream to the north of I-86, and groundwater from the Portneuf River Valley hydrogeochemical regime is discharging directly to the baseflow of the river. It appears that Batiste Spring is associated with the Bannock Range hydrogeochemical regime and that Swanson Road Spring is associated with the Portneuf River Valley regime.

A list of wells in the vicinity (near the west bank) of the Portneuf River that have elevated concentrations of common ions, nutrients, and metals, and levels of physical parameters above or below representative levels is provided in Table 4.5-1. The values presented in this table are mean concentrations calculated using groundwater data from June 1992 through March 1993. Concentrations exceeding two times the standard deviation (2XSD) for representative groundwater are presented in bold type. Concentrations that are within representative (2XSD) groundwater limits, but exceed ranges for representative upgradient wells within the appropriate regime, are presented in italic type.

Groundwater chemistry in the shallow wells along the left bank of the river is representative of the Portneuf River Valley hydrogeochemical regime. Groundwater chemistry of deeper wells and wells at increasing distance to the west of the Portneuf River is representative of the Bannock Range hydrogeochemical regime. Section 4.4.1 established limits for parameters in representative groundwater in general and representative groundwater concentration ranges for each hydrogeochemical regime. The limits for general representative groundwater and the ranges for these two regimes are also provided in Table 4.5-1.

Nested Wells 318 (shallow) and 317 (deeper) and Wells TW-12S, 327, Frontier, and 503 have the highest concentrations of parameters (such as arsenic, lithium, orthophosphate, total phosphorus, and sulfate) and the greatest number of parameters with elevated concentrations (Table 4.5-1). The natural levels of common ions in groundwater in these wells have been masked by constituent loading due to releases from the EMF facilities operations areas. Therefore, it is difficult to establish the pre-existing water chemistry for these wells.

As shown in Table 4.5-1, Well 505 (the shallow member of the 505/504 well pair) and the Batiste Spring groundwater sampling station have mean sulfate concentrations (40 to 81 mg/l) approximately twice the mean (26 mg/l) detected in

Bannock Range representative groundwater and generally greater than the mean plus 2XSD value for sulfate in Bannock Range representative groundwater (47 mg/l). The mean concentrations of fluoride in Wells 504, TW-11S, and TW-11I are marginally higher (i.e., 0.7 to 0.8 mg/l) than the mean fluoride concentration (0.5 mg/l) in Bannock Range representative groundwater. However, the fluoride concentrations in these wells are less than or equal to the mean plus two standard deviations for fluoride detected in Bannock Range Representative groundwater (0.8 mg/l). Common ion concentrations in groundwater from these wells have not been grossly impacted, and the natural water chemistry can be readily identified.

4.5.1.3 FMC IWW Ditch and Outfall

The IWW basin is designed to receive noncontact cooling water for the calciner and furnaces. Groundwater from FMC production Wells FMC-1 and FMC-3 is the source of the water used for cooling. After aeration for cooling purposes, wastewater is discharged from the IWW pond through the IWW ditch. The IWW ditch drains to a culvert that exits the facility and eventually discharges into the Portneuf River at the FMC outfall. River sampling station SW17 is located downstream of this discharge.

By design, cooling water does not come into contact with the materials being processed in the calciner and furnaces. Therefore, this noncontact cooling water should not contain process-related parameters that are not present in groundwater. However, analysis of samples of water and sediments collected from the IWW ditch during the Phase I RI sampling program showed elevated levels of process-related parameters, although these levels were not detected in subsequent samples collected during Phase II. Tables 4.5-2 and 4.5-2A present concentrations for parameters found in representative groundwater, groundwater from production Well FMC-1 (September 1990 data), water from the IWW ditch, and surface water collected at river sampling station SW17.

A grab sample of IWW ditch water was taken during Phase I and analyzed for inorganics and radioactivity. The results of these analyses indicated that the ditch water contained a number of parameters above representative groundwater and upstream river water concentrations (Table 4.5-2): arsenic (1.76 mg/l), cadmium (0.034 mg/l), copper (0.163 mg/l), fluoride (61.6 mg/l), total phosphorus (2,590 mg/l), potassium (7,470 mg/l), selenium (4.2 mg/l), sulfate (8,400 mg/l), and zinc (5.25 mg/l). During Phase II, 14 time-composite samples were taken of the ditch water over a 2-week period (July 1993); the three highest flow and three lowest flow samples were sent to the laboratory for analyses.

The results of these analyses indicate a significantly better water quality than that found in the ditch in Phase I (Table 4.5-2A). All six of the Phase II samples have water quality similar to that found near the production well (FMC-1) as characterized by Well 125.

Among the six composite samples collected during Phase II, the mean concentration of arsenic (total) was 0.0068 mg/l, while the highest concentration detected in a single sample was 0.010 mg/l (dissolved arsenic). The mean concentration of cadmium (total) was 0.0015 mg/l, while the highest single sample concentration was 0.0041 mg/l (dissolved cadmium). Copper was not detected. The mean concentration of fluoride was 0.65 mg/l, while the highest single sample concentration was 0.7 mg/l. The mean concentration of total phosphorus was 0.48 mg/l, while the highest single sample concentration was 0.85 mg/l. The mean concentration of potassium (total) was 8.29 mg/l, while the highest single sample concentration was 9.61 mg/l (dissolved potassium). Selenium was not detected. The mean concentration of sulfate was 75 mg/l, while the highest single sample concentration was 80 mg/l. Zinc was not detected.

The IWW ditch was also sampled by EPA in July 1993 during an inspection conducted by the EPA National Enforcement Investigations Center. The results of this sample are included in Table 4.5-2A. Twelve of the 16 constituents analyzed were not detected. Of the remaining four, arsenic (total) was detected at 0.017 mg/l, fluoride at 0.7 mg/l, orthophosphate at 0.58 mg/l, and total phosphorus at 0.7 mg/l.

Gross alpha and beta activities were both enriched in the Phase I water sample (155 ± 95.9 pCi/l and $6,890 \pm 145$ pCi/l). Gross alpha activities in the Phase II samples were either not detected (2 pCi/l) or within the groundwater representative levels. Gross beta activities were also low. However, there was one sample (IWG, July 29, 1993) collected during Phase II in which radium-228 was detected at 6.5 ± 0.8 pCi/l.

The results of the Phase II and NEIC analyses indicate that there is no longer an impact from the drainage ditch water; the time composites are representative of the Michaud Flats groundwater associated with Well 125. FMC management has begun an investigation of what changes in operation may have caused the differences observed between the Phase I, Phase II and NEIC results. A future sampling event is planned by FMC to confirm the Phase II and NEIC findings.

4.5.1.4 Pocatello STP

The Pocatello STP is located on the east bank of the Portneuf River, within the EMF study area. The facility uses an activated sludge secondary treatment process to remove 90 to 95 percent of the organic material from the City of Pocatello

wastewater. The plant was not designed to remove nitrogenous compounds, and inorganic nitrogen in the effluent is a mix of ammonia and nitrate forms (City of Pocatello, 1989). Gaseous chlorine is used to disinfect the effluent prior to outfall, and a sulfonation process reduces the residual chlorine prior to discharge. The system is capable of zero residual chlorine, and is operated to meet the National Pollutant Discharge Elimination System (NPDES) permit requirement of less than 0.5 mg/l residual chlorine in the discharge. The Pocatello STP discharges this treated water in compliance with its federal NPDES permit to the Portneuf River.

River sampling station SW/SD12 is located immediately downstream from the STP discharge pipe. In addition to the STP discharge, several springs are present within the STP operations area. The volume of these springs' discharge is about 25 times the volume of water discharged by the City's treatment facility. Spring sampling station SW13 is located in the area of a major spring discharge within the STP operations area. The STP discharge is located downstream of the STP.

In preparation for getting the NPDES permit, the City conducted a water quality and bioassessment of the Portneuf River in 1989, above and below the City's point of effluent discharge. Biological oxygen demand (BOD₅) and total suspended solids are each typically lower than 20 mg/l. The study monitored ammonia-nitrogen (NH₃-N) and dissolved oxygen (DO) downstream of the STP. These water quality parameters are of acute importance to aquatic life. Ammonia ranged in monthly mean values from 10 to 33 mg/l NH₃-N. During late summer, effluent DO ranged from 6 to 7 mg/l throughout the 24-hour monitoring period. Dissolved oxygen typically equaled or exceeded the concentration in the Portneuf River during the critical time for DO in a receiving stream from midnight to sunrise.

Electrical conductivity, which can be directly correlated with dissolved solids, ranged from 1.7 to 2.1 microsiemens per centimeter (mS/cm) during the summer of 1989. This range was several times higher than the one observed in the river. Table 4.5-3 presents a summary of the City's characterization of STP effluent quality.

Although the STP overflow rate is not substantial compared with the river flow, the RI has shown that there is a measurable, albeit modest, impact on the water quality in the area immediately downstream of the STP discharge. However, the STP was in compliance with its NPDES discharge permit. This impact is generally confined to the water quality parameters, nitrates, sodium, phosphates, and ammonia.

The mean concentration of ammonia (3.4 mg/l) at the sampling location below the STP discharge (SW12) was higher than those at all upstream locations (which ranged from nondetect to 0.3 mg/l). Also, the mean concentrations of total phosphorus (1.05 mg/l) and orthophosphate (0.97 mg/l) were higher than those at

the nearest upstream sampling location (SW17) (0.64 mg/l total phosphorus and 0.32 mg/l orthophosphate.) The mean concentrations of nitrate (2.09 mg/l) and sodium (55.1 mg/l) were also higher than the mean concentrations of these constituents in upstream samples.

Wastewater sludge from the STP is periodically applied to the land surface in an area north of the EMF facilities on the left bank side of the Portneuf River. This area is in the vicinity of Wells 514, 515, and 516.

4.5.1.5 Fish Farms

Two fish farms are located along spring drainage channels on the west bank of the Portneuf River, within the EMF study area. Spring sampling station SW/SD11 is located upstream of the Batiste Springs Fish Farm operations area, and river sampling station SW/SD10 is at the mouth of the spring drainage discharge below the Batiste Springs Fish Farm. The water quality measured by surface water sampling station SW/SD10 is in the mixing zone. Sampling stations SW/SD7, SW/SD6, and SW/SD5 are located within the drainage and at the Papoose Springs discharge. The Papoose Springs Fish Farm is located within the Papoose Springs drainage. During the fourth round of quarterly sampling, additional locations 5E and 5F were sampled in the east and west channels directly below the Papoose Springs Fish Farm. Chemical contributions of fish farms to receiving waters are primarily ammonia, other nitrogen and phosphorus compounds, BOD, and suspended solids (Spotte, 1970).

On the basis of the RI, it appears that the fish farms are contributing above-representative levels of nitrates and phosphates to spring water, which discharges to the Portneuf River. The river water sample locations 5E and 5F have elevated levels of nitrates, which are attributable to the STP discharge.

4.5.2 Characterization of Trace Metals, Nutrients, and Radiological Parameters in Surface Water

The following section describes trace metal, radiological, nutrient, and other parameters detected in surface water samples collected during the RI sampling program. Quarterly surface water samples were taken for constituent analysis from the Portneuf River and springs (and spring drainages) at 24 locations (sample locations SW1 to SW17, and SW19 to SW25). These locations ranged from approximately 6 miles (9.6 km) upstream of the EMF facilities (SW25), to 4 miles (7.4 km) downstream of the site (SW1). Surface water sample locations are shown in relation to the Portneuf River in Figure 4.5-1 and in the following map (Figure 4.5-2).

Of the 24 surface water sample locations, 14 locations were within the river. During the last quarter of sampling (April 1992), additional samples were collected at two river locations (7E and 12E) and two spring locations (5E and 5F). To confirm preliminary Phase I results, additional river samples were collected during Phase II from a transect in the vicinity of the FMC outfall, next to SW17 (17A to 17I).

In evaluating whether there has been an impact on surface water quality by the EMF facilities, the following methodology was used:

- Concentrations of parameters detected in springs (and spring drainages) were compared to representative groundwater levels, and upstream river surface water concentrations. Spring surface water concentrations were also compared with each other.
- Sampling results from gaining-reach river sampling stations were compared to concentrations at losing-reach stations. In addition, concentrations from river sampling locations in the vicinity of the EMF facilities (SW17 to SW20) were compared to concentrations at other losing-reach stations.
- Where applicable, local impacts as a result of effluent discharges (such as the STP and FMC outfall) or other operations (such as the fish farms) were also taken into consideration.
- Dissolved and total samples were compared to determine turbidity.

Several previous investigations were conducted at springs in what is now referred to as the EMF study area. These studies are discussed in Section 1.3 and in Appendix A of the PSCS and where appropriate, incorporated into the analysis in this section.

The following sections present the results and evaluate the impacts of constituents of potential concern on surface waters of the Portneuf River and springs in the EMF study area. A brief summary of the RI findings is first presented in Section 4.5.2.1. Sections 4.5.2.2 and 4.5.2.3 address the metals and radiological parameters detected in surface water, respectively. Section 4.5.2.4 discusses the nutrients (including sulfate) detected in surface water.

4.5.2.1 Summary of Trace Metals, Nutrients, and Radiological Parameters in Surface Water

Constituents found in surface water during the RI sampling program include metals such as arsenic and lithium. In addition, nutrients (including nitrate, orthophosphate, and total phosphorus) have been identified to be present at concentrations above representative levels. A summary of elevated parameters

found in surface water at above-representative concentrations is presented in Table 4.5-4.

An evaluation of the chemical analyses of surface water samples and their locations with respect to river and spring geometry led to the following conclusions:

- Constituent loading in Batiste and Swanson Road springs does not appear to have a measurable impact on river water quality.
- The EMF facilities have contributed to the observed elevated levels of arsenic, sulfate, total phosphorus, and orthophosphate at Batiste Spring (SW14) and Swanson Road Spring (SW15). Lithium was also found at Batiste Spring.
- Several constituents routinely detected in other springs and in river water samples (e.g., boron, lithium, and vanadium) appear to be naturally occurring. Elevated metal concentrations potentially associated with EMF operations in the Portneuf River were limited to copper, in the vicinity of the FMC outfall.
- Enriched concentrations of nitrates were found in Batiste Spring at levels higher than in the spring drainage channel or in river surface water samples. There are several potential sources for the nitrate in Batiste Spring, including agriculture, the EMF facilities, natural leaching, and land application of sludge.
- Total phosphorus and orthophosphate found in surface water samples are attributable to the fish farms and the STP discharge.
- Radiological parameters were present at comparable levels in the spring and river surface water samples collected. Moderate variations do not appear to be site related. Uranium-235 and uranium-238 were not detected in any surface water sample collected.
- Inconsistent results were obtained between the samples of the FMC outfall collected during the Phase I and Phase II sampling results. Phase I samples indicated the presence of above-representative concentrations of metals (including arsenic, lithium, and copper) and nutrients (including orthophosphate, total phosphorus, and nitrate). However, with the exception of copper, Phase II samples did not confirm Phase I findings.

More detailed information on these findings is presented in the following sections.

4.5.2.2 *Metals Detected in Surface Water*

The following discussion of metals in surface water within the EMF study area describes results of analyses of samples from springs and river sampling stations for 22 alkali metals, alkaline earths, and trace metals. Table 4.5-5 presents results for springs, and Table 4.5-6 presents results for river sampling stations. Each table is a comparison of mean concentrations for each parameter at each sampling point over four quarters of RI sampling. Both dissolved and total metal concentrations for each parameter are shown in these tables. Mean dissolved concentrations sometimes exceed mean total concentrations for individual springs or river sampling stations, and for group and all-river means for river sampling stations. This discrepancy results from analytical or validation procedures. Appendix E presents metals analysis results with validation qualifiers for individual samples collected during each round of RI sampling.

Table 4.5-7 presents the representative groundwater levels for metals, as developed in Section 4.4.1.

Metals Detected in Springs. Metals that were detected in samples from the 12 springs and spring-drainage sampling points during the course of the RI are listed in Table 4.5-5.

Seventeen of the 22 metals for which spring-related samples were analyzed were either not detected, detected sporadically, or detected only at concentrations near detection limits (Table 4.5-8).

Of the remaining five metals, arsenic was found at above-representative concentrations characteristic of the groundwater systems that discharge at these springs (Batiste and Swanson Road) (i.e., 0.021 mg/l in the Bannock Range hydrogeochemical regime, and 0.009 mg/l in the Portneuf River Valley regime). The EMF facilities have contributed to the observed elevated levels of arsenic.

Lithium is found consistently in spring samples, but at levels comparable in representative groundwater. With the exception of Batiste Spring, the occurrence of lithium is generally unrelated to EMF facilities-related activities. Higher concentrations of lithium at Batiste Spring (SW14) can be related to elevated levels of lithium found in groundwater from beneath the EMF operations areas. However, lithium concentrations in surface water samples collected upstream from the influence of the EMF facilities exceeded the concentrations present in any spring sample, including those from Batiste Spring.

Section 4 Nature and Extent of Constituents of Potential Concern

Boron, barium, and vanadium were detected routinely in spring samples from all four spring systems (below representative concentrations) and are most likely naturally occurring.

The following discusses RI findings with respect to the five constituents determined to be present at elevated concentrations.

Arsenic. Arsenic was detected in at least two rounds of sampling for all spring and spring-drainage sampling points. Highest mean arsenic concentrations are for Batiste Spring (0.032 mg/l dissolved) and Swanson Road Spring (0.010 mg/l dissolved) (See Table 4.5-5). However, arsenic was not detected in the samples collected at Batiste Spring in October 1992, nor was dissolved arsenic detected in samples from both springs collected in February 1993. These are higher than the representative concentrations for groundwater that is related to the discharges at Batiste Spring and Swanson Road Spring (0.021 mg/l Bannock Range regime associated with Batiste Spring, and 0.009 mg/l Portneuf River Valley regime associated with Swanson Road Spring). The highest mean arsenic 0.004 mg/l (dissolved) 0.005 (dissolved)) for the East Side System and Papoose System springs and spring-drainage sampling points are below representative groundwater levels for groundwater and are consistent with representative levels of arsenic in the Portneuf River Valley hydrogeochemical regime.

A component of the arsenic concentrations detected at Batiste Spring and Swanson Road Spring appears to indicate the impact of the EMF operations areas. Arsenic is an EMF facilities-related parameter; in addition, arsenic concentrations in groundwater decrease from elevated concentrations (mean concentrations from 0.18 to 0.57 mg/l total arsenic and ND to 8.42 mg/l dissolved arsenic) within the EMF operations areas to near representative groundwater levels in wells adjacent to the Portneuf River. The upper limit for arsenic in representative groundwater (0.021 mg/l in the low-chloride subgroup of the Bannock Range Regime) is presented in Table 4.5-7. Mean arsenic concentrations at Batiste Spring were above this level.

Maximum arsenic concentrations for SW15 (0.0134 mg/l dissolved) occurred during the October 1992 sampling event. Arsenic was reported as below detection at SW14 during the October 1992 sampling event. Maximum arsenic concentrations for SW14 (0.057 mg/l dissolved) occurred during the April 1993 sampling event.

For sampling point SW11, located in a pond off the drainage channel downstream from Batiste Spring, arsenic was detected during only two sampling events. The maximum concentration (0.008 mg/l total) was detected during April 1993. This is the same sampling event for which Batiste Spring had maximum concentrations.

Barium. Barium concentrations in springs are comparable to representative groundwater levels (0.16 mg/l, low-chloride Bannock Range; and 0.19 mg/l, Portneuf River Valley). Barium was detected routinely in samples from spring and spring-drainage sampling points.

The mean barium concentrations (among both total and dissolved samples) shown in Table 4.5-5 range from 0.064 to 0.123 mg/l (below representative groundwater levels) for all sampling points except Twenty Springs-East. The mean total barium concentration for Twenty Springs-East (SW02) is 0.760 mg/l. This mean concentration may be artificially high because of a single measurement (2.81 mg/l during July 1992). Using only subsequent sampling data to calculate the mean total barium concentration for SW02 gives a value of 0.077 mg/l. This lower mean concentration is consistent with mean concentrations for other springs.

Boron. Boron was detected in at least two rounds of sampling for all spring and spring-drainage sampling points. Highest mean boron concentrations are for Swanson Road Spring (0.28 mg/l total and 0.21 mg/l dissolved) and SW13, the springs near the STP (0.24 mg/l total and 0.22 mg/l dissolved). However, these concentrations are below the representative groundwater levels for Portneuf River Valley hydrogeochemical regime (0.37 mg/l). In addition, Batiste Spring (SW14), Batiste Springs drainage (SW11), and Papoose Spring (SW07) also have mean boron concentrations below representative levels (0.39 mg/l, Bannock Range). Since boron is found in all four spring groups, it is most likely naturally occurring.

Lithium. Lithium was detected in at least three rounds of sampling for all spring and spring-drainage sampling points. Highest mean lithium concentrations are for Batiste Spring (0.051 mg/l total and 0.053 mg/l dissolved) (Table 4.5-5). These concentrations are above the representative level for Bannock Range groundwater (0.013 mg/l) and comparable to elevated levels (0.047 to 0.051 mg/l) in Wells TW-11S and TW-11I near Batiste Spring and the Portneuf River (see Table 4.5-1).

Lithium concentrations for the Papoose systems spring and spring-drainage points range from not detected to 0.038 mg/l (total) and from 0.024 to 0.039 mg/l (dissolved) greater than the representative level for Bannock Range groundwater (0.013 mg/l). Mean lithium concentrations for the Swanson Road and East Side systems range from 0.023 to 0.044 mg/l, and are comparable to the representative level (0.043 mg/l) for Portneuf River Valley representative groundwater. Most likely, a portion of the lithium detected in Batiste Spring is associated with the elevated levels in groundwater originating from the EMF facilities operations areas.

Lithium levels were higher in river water upstream of the EMF operations areas (SW23 to SW25) compared with the levels detected in springs (see Table 4.5-6).

Mean lithium concentrations in samples from river sampling stations decreased from a high value of 0.058 mg/l in both total and dissolved lithium in the two stations furthest upstream of the EMF study area (SW25 and SW24) to a mean concentration of 0.037 mg/l for both total and dissolved lithium in gaining-reach river sampling stations. Figure 4.5-3 illustrates this trend in lithium concentrations for spring sampling points and for river sampling stations.

The EMF facilities have contributed to the observed elevated levels of lithium in Batiste Spring. Lithium concentrations for other spring-related sampling points are also higher than the representative level for groundwater (0.013 mg/l, Bannock Range; and 0.043 mg/l, Portneuf River Valley), but they most likely represent naturally occurring levels consistent with higher lithium concentrations for river water.

Higher lithium concentrations in the Portneuf River Valley groundwater can be attributed to recharge from upstream river water with higher lithium concentrations. In turn, higher lithium concentrations in the East Side and Swanson Road springs can also be attributed to lithium in river water upstream of the EMF study area.

Vanadium. Vanadium concentrations were near detection limits in most samples from spring and spring-drainage sampling points in the EMF study area. With the exception of one sampling event (July 1992), reported concentrations of vanadium (0.003 to 0.011 mg/l) are near or below the IDL (0.008 mg/l) (Appendix E). These concentrations were below the representative levels for groundwater (0.103 mg/l, Bannock Range; and 0.331 mg/l, Portneuf River Valley).

Vanadium was detected in all three of the first rounds of sampling for six of the ten spring and spring-drainage sampling points sampled over four rounds: SW14 and SW11 of the Batiste System, SW15 of the Swanson Road System, SW09 of the East Side System, and SW07 and SW05 of the Papoose System.

The mean vanadium concentrations presented in Table 4.5-5 are not a clear representation of vanadium detected over four rounds of surface water sampling, as concentrations varied by two orders of magnitude. During the initial round of surface water sampling in July 1992, reported vanadium concentrations for spring-related sampling points (0.04 to 0.13 mg/l) were much higher than for subsequent rounds of sampling (maximum 0.011 mg/l). During the April 1993 round of sampling, vanadium was not detected in any surface water sample.

This trend in vanadium concentrations is illustrated for a sampling point from each of the four spring systems in Figure 4.5-4. Based on the four rounds of sampling, it is possible that this trend reflects the normal seasonal fluctuation in vanadium

concentrations. Alternatively, this trend may be an artifact of field or laboratory procedures which resulted in artificially high vanadium concentrations for July 1992.

Metals Detected in the Portneuf River. Metals that may be related to the EMF site that were detected in Phase I and Phase II RI samples from river sampling stations are listed in Table 4.5-6.

Thirteen of the 22 metals for which river water samples were analyzed, were either not detected or were detected only in concentrations near the detection limits (see Table 4.5-8). They are as follows:

- Antimony
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Lead
- Mercury
- Molybdenum
- Nickel
- Selenium
- Silver
- Thallium
- Zinc

Of the remaining nine metal constituents, aluminum, iron, and manganese were routinely detected in river water, but increased concentrations were directly related to increased turbidity and flow of the river. Barium, lithium, and vanadium were routinely detected and appear to be naturally occurring in the river.

Arsenic concentrations in river water were low compared with concentrations in representative groundwater. The maximum reported arsenic concentration (0.011 mg/l) was collected during Phase I in a sample from SW17 (at the FMC outfall). However, subsequent Phase II sampling at SW17 indicated arsenic concentrations of 0.007 mg/l, substantially lower than the Phase I sampling results. Highest

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individual station means (0.007 mg/l total arsenic) were for four of the losing-reach stations, SW20 through SW18 plus SW16.

The widespread distribution of boron in river water suggests that it is not related to the EMF facilities. A slightly higher mean boron concentration for SW17 was found during the Phase I RI. Subsequent sampling conducted during Phase II at SW17, however, did not confirm Phase I findings, and it appears that the FMC outfall was no longer affecting surface water quality. Samples collected from the IWW ditch during Phase II were representative of Michaud Flats groundwater.

For river sampling station SW17 at the FMC outfall, Phase I mean copper concentrations were approximately double the mean concentration for all river samples. These findings are comparable to Phase II results. The higher concentrations at SW17 may represent an impact from the FMC outfall.

The following presents details on the nine metal constituents that were present at or above representative levels at surface water sampling locations in the Portneuf River.

Aluminum. Total aluminum was detected routinely in samples from the majority of river sampling stations in the losing reach of the Portneuf River: SW25, SW24, SW23, SW20, SW19, and SW16. Mean total aluminum concentrations presented in Table 4.5-6 for the remaining losing-reach sampling stations and for all gaining-reach sampling stations represent one or two samples in which aluminum was reported. Mean concentrations for dissolved aluminum (also presented in Table 4.5-6) represent one or two samples. Dissolved aluminum is not considered to be present in all river water in the EMF study area.

The presence of aluminum in surface water samples as total aluminum rather than dissolved aluminum is generally an indicator of a turbid water sample. This is illustrated by comparing total aluminum concentrations with riverflow. Total aluminum was detected in all river samples for April 1993 when riverflow was at a maximum for all sampling events.

The mean total aluminum concentrations for four rounds of sampling, presented in Table 4.5-6 in the row labeled "4 events," are not a clear representation of aluminum detected over four rounds of surface water sampling because concentrations varied by two orders of magnitude. Total aluminum concentrations ranged from below detection to 0.32 mg/l for losing-reach river samples for the first three rounds of sampling. However, total aluminum concentrations ranged from 0.90 to 1.73 mg/l for losing-reach river samples for the April 1993 round of sampling. Figure 4.5-5 illustrates this trend in total aluminum concentrations for losing-reach river sampling stations SW25 and SW16.

For river sampling station SW17 at the FMC outfall, the mean concentration for total aluminum (1.02 mg/l) represents only one sample (April 1993). Total aluminum concentrations ranged from below detection to 0.44 mg/l for gaining-reach river samples for the first three rounds of sampling. However, total aluminum concentrations ranged from 0.90 to 1.80 mg/l for gaining-reach river samples for the Phase I April 1993 round of sampling.

Comparison of group means provided in Table 4.5-6 for losing-reach versus gaining-reach river sampling stations shows that during low riverflow sampling events (first three events), mean total aluminum concentrations were the same for both reaches (0.18 mg/l). However, during high flow sampling events (April 1993 row), mean total aluminum was greater for losing-reach river sampling stations (1.38 mg/l) than for gaining-reach river sampling stations (1.19 mg/l). This is probably attributable to the increased flow in the gaining reach of sediment-free groundwater underflow which would tend to dilute the TSS values.

In summary, total aluminum detected in river water samples was a result of the presence of suspended solids. Aluminum was not present as a dissolved phase in river water. Seasonally high levels of total aluminum result from increased turbidity, which occurs during periods of increased flow in the Portneuf River.

Arsenic. Arsenic concentrations in river water were low compared with concentrations in representative groundwater (0.021 mg/l, Bannock Range; and 0.009 mg/l, Portneuf River Valley) (see Tables 4.5-6 and 4.5-7).

Arsenic was detected in at least two rounds of sampling for all river sampling stations except SW16 (and SW18, which was only sampled once). Mean total arsenic concentrations were marginally higher for the losing-reach group of river sampling stations (0.006 mg/l) than for the gaining-reach group (0.004 mg/l). Highest individual station means were for the four losing-reach stations, SW20 through SW18 plus SW16. With the exception of SW17, these four river sampling stations are nearest to and downstream of the EMF facilities. However, the mean calculation for these sampling points is based on two samples rather than the four taken. The two not used were below detection limits or eliminated by the validation process. If they had been used in the calculations, then the mean would have been considerably lower. Maximum reported arsenic concentration (0.011 mg/l) was for a Phase I sample from SW17, which is at the FMC outfall.

Subsequent Phase II samples collected at SW17 indicate mean arsenic concentrations of 0.0029 mg/l, substantially lower than Phase I sampling results.

In the gaining reach, arsenic concentrations in river water (group mean 0.004 mg/l) were comparable to concentrations in representative groundwater of the Portneuf River Valley hydrogeochemical regime (0.009 mg/l). This further emphasizes the dominance the Portneuf River Valley hydrogeochemical regime has on the water quality of the gaining reach of the Portneuf River.

Barium. Barium concentrations in river water in the EMF study area were near detection limits. Barium was detected routinely in samples from all river sampling stations. However, all mean barium concentrations were below the representative level for groundwater (0.16 mg/l, Bannock Range; and 0.19 mg/l, Portneuf River Valley). The widespread distribution of this parameter suggests that barium is naturally occurring in river water.

Boron. Boron was detected in at least two rounds of sampling for all river sampling stations. The highest mean boron concentrations were for SW17 at the FMC outfall (0.38 mg/l total and 0.23 mg/l dissolved) (see Table 4.5-6) during the Phase I RI, and for the losing-reach station SW25 (0.33 mg/l total and 0.23 mg/l dissolved). These two sampling stations plus losing-reach stations SW24, SW23, SW19, and SW16 and gaining-reach stations SW12 and SW10 had mean total boron concentrations (0.19 to 0.27 mg/l), below the representative levels for groundwater (0.040 mg/l, Bannock Range; and 0.37 mg/l, Portneuf River Valley). However, with the possible exception of boron at Phase I SW17, the widespread distribution of this parameter suggests that boron in river water is not related to the EMF facilities. With respect to Phase I SW17 results, the maximum boron concentration found during subsequent Phase II sampling at SW17 was 0.11 mg/l, well below the representative groundwater level of 0.40 mg/l (Bannock Range).

Copper. Copper was not detected in any sample for a number of river sampling stations. With the exception of Phase I SW17, mean copper concentrations in Table 4.5-6 represent one or two samples in which copper was reported. The reported concentrations were, except for those for SW17, near the Instrument Detection Limit (IDL) (0.003 mg/l), and consequently, copper is not considered to be present in surface water in the Portneuf River in the EMF study area. The lack of a distinguishable plume down stream indicates that discharge releases from July 1992 through April 1993 did not have an impact on general river quality.

For river sampling station SW17 at the FMC outfall, mean Phase I copper concentrations (0.015 mg/l total and 0.011 mg/l dissolved) were approximately double the mean concentration for all river samples (0.007 mg/l) for both total and dissolved copper. Copper was also detected routinely at SW17. As shown in Table 4.5-2, copper concentration for water in the IWW ditch was 0.163 mg/l. Phase II

sampling data at SW17 show a mean copper concentration of 0.007 mg/l, with values ranging from ND to 0.011 mg/l. (Copper was undetected in the dissolved form.) The Phase II SW17 results were comparable to Phase I results.

Iron. Total iron was detected in river water samples as a result of suspended solids and was not present as a dissolved phase in river water. Seasonally high levels of total iron resulted from increased turbidity that occurs during periods of increased flow in the Portneuf River. Total iron was routinely detected at all river sampling stations except SW25 and was present at higher concentrations in the losing reach than in the gaining reach of the Portneuf River.

Iron, as total iron, was routinely detected in samples from all Portneuf River sampling stations, except SW25. Mean dissolved iron concentrations (see Table 4.5-6) for all the river sampling stations and mean total iron for SW25 represent one or two samples in which iron was reported. Dissolved iron was near detection limits in all river water in the EMF study area.

In the same manner as for aluminum, the presence of iron in surface water samples as total iron rather than dissolved iron is generally an indicator of a turbid water sample. This is illustrated by comparing total iron concentrations with riverflow. Total iron was detected in all river samples for April 1993 when riverflow was at a maximum for all sampling events.

The mean total iron concentrations are not a clear representation of iron detected over four rounds of surface water sampling, as concentrations varied by two orders of magnitude. Total iron concentrations ranged from below detection to 0.32 mg/l for all river samples for the first three rounds of sampling (Appendix E). However, total iron concentrations ranged from 0.94 to 1.73 mg/l for all river samples for the April 1993 round of sampling. Figure 4.5-6 illustrates this trend in total iron concentrations for losing-reach river sampling stations SW22 and SW16 and gaining-reach river sampling stations SW10 and SW08.

Comparison of group means provided in Table 4.5-6 for losing-reach versus gaining-reach river sampling stations shows that during both the low-river flow (first three events) and high-river flow (April 1993 row) sampling events, mean total iron concentration was greater for the losing-reach river sampling stations than for gaining-reach river sampling stations.

Lithium. Lithium was detected in samples from all river sampling stations except gaining-reach stations SW12E (dissolved lithium) and SW7E (total lithium). Mean lithium concentrations for all river sampling stations were comparable to or higher than the representative levels for groundwater (0.013 mg/l, Bannock Range;

and 0.043, Portneuf River Valley). However, both total and dissolved mean lithium concentrations decreased through the losing reach and from the losing reach to the gaining reach. Lithium was present at higher levels in river water well upstream from the EMF facilities than in representative groundwater, and its presence does not represent an impact from the EMF facilities.

As shown in Table 4.5-6, mean lithium concentrations in samples from river sampling stations decreased from a high value of 0.58 mg/l total lithium in the two stations furthest upstream (SW25 and SW24) to a mean concentration of 0.037 mg/l (both total and dissolved) for lithium in gaining-reach river sampling stations. Figure 4.5-3 illustrates this trend in lithium concentrations for river sampling stations and also shows lithium concentrations for spring sampling points.

Manganese. Total manganese was routinely detected at all river sampling stations except SW21, and was present at higher concentrations in the losing reach than in the gaining reach of the Portneuf River. For the July 1992 round of sampling, manganese was reported in only two samples (0.037 mg/l for SW20 and 0.012 mg/l for SW01).

Total manganese was detected in river water samples as a result of suspended solids and was not present as a dissolved phase in river water. Seasonally high levels of total manganese resulted from increased turbidity which occurred during periods of increased flow in the Portneuf River. Mean dissolved manganese concentrations (see Table 4.5-6) for all river sampling stations and mean total manganese for SW21 represent one or two samples in which manganese was reported. Dissolved manganese was near detection limits in all river water in the EMF study area.

In the same manner as for aluminum and iron, the presence of manganese in surface water samples as total manganese rather than dissolved manganese is generally an indicator of a turbid water sample. This is illustrated by comparing total manganese concentrations with river flow. Total manganese was detected in all river samples for April 1993, when river flow was at a maximum for all sampling events. Stream flow measurements taken concurrently with surface water samples during four rounds of surface water sampling are shown in Figure 4.5-5.

The mean total manganese concentrations presented in Table 4.5-6 are not a clear representation of manganese detected over four rounds of surface water sampling, as concentrations increased twofold to fourfold for the April 1993 sampling event. Total manganese concentrations ranged from below detection to 0.014 mg/l, with the exception of one higher value for all river samples for the first three rounds of sampling. However, total manganese concentrations ranged from 0.037 to 0.062 mg/l for all river samples for the April 1993 round of sampling. This trend in total

manganese concentrations for losing-reach river sampling stations SW25 and SW16 and gaining-reach river sampling stations SW12 and SW03 is illustrated in Figure 4.5-7.

Comparison of group means provided in Table 4.5-6 for losing-reach versus gaining-reach river sampling stations shows that mean total manganese concentration was approximately the same for the losing-reach and gaining-reach river sampling stations.

Vanadium. Vanadium concentrations were near detection limits in samples from river sampling stations in the EMF study area. For four rounds of sampling (July and October 1992 and February and April 1993) reported concentrations of vanadium (mean 0.016 mg/l) at near or below the IDL (0.008 mg/l). These concentrations were below the representative levels for groundwater (0.103 mg/l, Bannock Range; and 0.331 mg/l, Portneuf River Valley).

The mean vanadium concentrations presented in Table 4.5-6 are not a clear representation of vanadium detected over four rounds of surface water sampling, as concentrations varied by an order of magnitude. In July 1992, only ten losing-reach stations were sampled. During the initial round of surface water sampling in July 1992, reported vanadium concentrations for six river sampling stations were much higher (0.04 to 0.08 mg/l) than for subsequent rounds of sampling (maximum 0.003 mg/l). Vanadium was reported as below detection for the remaining nine river sampling stations for the July 1992 sampling event, but sample detection limits were very high (0.015 to 0.190 mg/l). During the April 1993 round of sampling, vanadium was not detected in any surface water samples, but sample detection limits were low (0.004 mg/l).

This trend in vanadium concentrations for losing-reach station SW17 (0.27 mg/l) and gaining-reach station SW01 (0.017 mg/l) is illustrated in Figure 4.5-8. Based on four rounds of sampling, it is possible that this trend is associated with the normal seasonal fluctuation in vanadium concentrations. However, this trend may alternatively be an artifact of field or laboratory procedures which resulted in artificially high vanadium concentrations for July 1992. However, it should be noted that subsequent Phase II sampling conducted at SW17 detected vanadium in only two of the seven samples collected, with mean vanadium concentrations of 0.002 mg/l. This was well below the Phase I mean concentration of 0.016 mg/l at SW17, indicating that the July 1992 sampling could be an artifact.

4.5.2.3 Radiological Parameters in Surface Water

In this section, the radiological parameters in surface water for the EMF study area are described. Results of analyses of samples from springs and river sampling stations for gross alpha, gross beta, radium-226, radium-228, and uranium-233/-234. Although samples were tested for uranium-235 and uranium-238, neither isotope was detected.

To assess the nature and extent of radiological parameters in springs (and spring drainages) that could be attributed to the EMF facilities operations, sampling results from spring sampling stations were compared with each other. Since subsurface water that has been impacted by site industrial activities is only likely to enter the surface water system through Swanson Road and Batiste springs, results for these two springs were also compared with the other spring sampling locations. Surface water springs sampling results are presented in Table 4.5-9.

With respect to the Portneuf River, radiological parameters in surface water samples collected from the gaining reach were compared with those collected from the losing reach. Particular consideration was given to sampling stations between SW16 and SW20 (in the vicinity of the EMF facilities), including SW17, located at the FMC outfall. Sampling results for river sampling stations are presented in Table 4.5-10. A tabulation of all radiological analyses for each surface water sample collected during the RI is presented in Appendix E.

Spring Results. An analysis of the radiological parameter activities in springs and spring drainages revealed no discernible trends that indicate potential anthropogenic impacts for gross alpha, radium-226, and radium-228. Gross alpha was detected frequently only in the Batiste System (SW14, SW11) (ranging from ND to 3.50 ± 1.17 pCi/l) and the East Side System (SW13, SW09) (ranging from ND to 5.55 ± 1.73 pCi/l). Gross alpha activities in these systems were comparable to each other and with levels present in the other springs. The maximum gross alpha of all of the springs was detected at Papoose Spring (SW07) (8.84 ± 2.30 pCi/l).

Radium-226 and radium-228 were detected in one or two rounds of sampling for four and seven of the 12 spring locations, respectively. Radium-226 was detected in three of four samples from Papoose Spring (SW07), with activity ranging from 1.40 ± 0.38 pCi/l to 1.93 ± 0.52 pCi/l. A higher than average concentration for radium-226 (5.20 ± 0.26 pCi/l) was detected for Papoose Spring discharge (SW05) during the October 1992 round of sampling. Radium-226 was also detected at Batiste Springs drainage (SW11) (2.60 ± 0.40 pCi/l) and Swanson Road Spring (SW15) (1.50 ± 0.62 pCi/l and $1.82 \pm$ pCi/l).

Radium-228 was detected in at least one round of sampling at all springs and spring-related sampling points except those in the Batiste System (SW14 and SW11) and the spring-fed pond at FMC park (SW09). Swanson Road Spring (SW15) radium-228 activities were comparable to levels detected at other spring surface water sampling stations. Highest activities of radium-228 were measured at Siphon Road Spring (SW04) (3.5 ± 0.9 pCi/l) and Twenty Springs-East (SW02) (5.3 ± 1.2 pCi/l).

Gross beta radiation was detected at every spring during every round of sampling. No one sampling round consistently exhibited the highest concentrations. A large percentage of gross beta radiation in spring samples can be accounted for by the natural abundance of potassium-40 (K^{40}), a beta emitter, in spring water. The natural radioactive decay calculated from K^{40} -derived beta emissions as a percentage of the gross beta emissions measured in the spring samples is presented in Table 4.5-11. It is apparent from this table that most, if not all, beta radiation can be accounted for by the naturally occurring radioisotope K^{40} in the spring water.

Samples from selected springs (SW14, SW13, and SW05) were analyzed for uranium isotopes during the February 1993 round of sampling only. Uranium-233/234 was detected in all three samples. Uranium-235 and uranium-238 were not detected. Since they are from two different groundwater systems, one of which is not impacted by EMF activities, these levels are probably natural.

Radiological parameters were consistently detected at springs of the Batiste and East Side systems but were not found at activities that were noticeably higher than at other springs. Swanson Road Spring had slightly higher gross beta activities than other springs. Historical measurements of gross alpha and gross beta at Batiste Spring (Goldstein, 1981) reported higher levels of both of these parameters. The same previous investigation found higher levels of gross alpha at Swanson Road Spring, but found levels of gross beta similar to or slightly lower than currently measured levels at this spring.

Portneuf River Results. As seen in Table 4.5-10, gross alpha radiation was detected at all river sampling station sampling points sampled during the February 1993 round of sampling. Gross alpha radiation was also detected in two or three rounds of sampling at SW25, SW23, SW22, SW20, SW19, SW16, and at all downstream river sampling stations.

Gross beta activities showed moderate variations from station to station, with no discernible trend indicating anthropogenic impacts. Gross beta radiation at river sampling stations was detected at every sampling point during every round of sampling, with the exception of SW21 during the fourth round of sampling. Over three rounds of sampling, upstream river sampling stations had somewhat higher

concentrations than downstream stations. The two highest measurements of gross beta (12.00 ± 2.00 and 13.80 ± 4.31 pCi/l) were at SW01 and SW23, respectively; however, these two stations also had the lowest measurements of gross beta in other rounds of sampling. Gross beta levels appeared to decrease from the furthest upstream river location (SW25) to the furthest downstream locations (SW03 and SW01).

As in spring samples, a large percentage of gross beta radiation in river water samples can be accounted for by the natural abundance of K^{40} , a beta emitter. Table 4.5-11 presents the natural radioactive decay calculated from K^{40} -derived beta emissions as a percentage of the gross beta emissions measured in the surface water samples. It is apparent from this table that most, if not all, beta radiation can be accounted for by the naturally occurring radioisotope K^{40} in the Portneuf River surface water.

Radium-226 was detected in one round of sampling at five river sampling stations (SW25, SW24, SW19, SW12E, and SW01) and in two rounds of sampling at two river sampling stations (SW17 and SW03). Radium-228 was detected at least once in all upstream river sampling stations except SW22 and was detected in three rounds of sampling at SW23, SW21, and SW20. Radium-228 was detected during one round of sampling at four of the five downstream river sampling stations (SW12E, SW12, SW07, and SW01). Sampling results for both radium-226 and radium-228 indicate only moderate variations, with no clear distinctions between losing-reach and gaining-reach sampling stations.

Samples from selected river sampling stations (SW25, SW24, SW22, SW17, SW10, and SW01) were analyzed for uranium isotopes during the February 1993 round of sampling only. Uranium-233/234 was detected at comparable activities in all six samples.

Both gross alpha and gross beta radiation appeared to be present at greater activities in river water than in spring water. Radiological parameters detected at river locations between SW20 and SW16 and at SW17 did not appear to be any higher than at other river locations.

4.5.2.4 Nutrients, Fluoride, and Sulfate Detection in Surface Water

Nutrients in surface water were discussed in Section 3 of the PSCS, as part of the characterization of general water chemistry. However, all of the nutrients tested for are components of processes at the EMF facilities, including total phosphorus, nitrate, and ammonia. Fluoride is also a component of processes at the EMF

facilities. Previous investigations (Ecology Consultants, 1977; Perry, 1977; Campbell et al., 1992) reported the presence of these parameters in surface water.

Mean Nitrate, total phosphorus, fluoride, and sulfate were found at concentrations exceeding representative groundwater levels at one or more of three locations that were also impacted by metals: Batiste Spring (SW14), Swanson Road Spring (SW15), and river sampling station SW17 at the FMC outfall (Tables 4.5-12 and 4.5-13). Mean Ammonia and sulfate were elevated at river sampling stations SW12 and SW12E at the Pocatello STP discharge.

Ammonia. Mean Ammonia concentrations were at representative groundwater levels (ND to 0.2 mg/l for Bannock Range; and ND to 0.9 mg/l for Portneuf River Valley) or below detection for all springs and for losing-reach river sampling stations. Mean Ammonia concentrations in the gaining reach were highest at SW12 and decreased with increasing distance downstream.

River station SW12 is located at the Pocatello STP discharge. Elevated concentrations of ammonia in surface water were likely attributable to the STP discharge. For the April 1993 sampling event, SW12E was also sampled. This station is located between losing-reach river sampling stations SW16 and SW12. Ammonia was not detected at SW16 or at SW12E, but was present at SW12 at a mean concentration of 3.4 mg/l.

The lack of ammonia in river water upstream of SW12 is further support that the STP discharge was the source of elevated ammonia in the gaining reach of the Portneuf River.

Nitrate. Nitrate (as nitrate-N) was detected at all spring-related sampling stations at mean concentrations from 1.40 to 4.44 mg/l (see Table 4.5-12 and Figure 4.5-9). The highest mean nitrate concentrations (2.64 to 4.44 mg/l) were found at the following four springs:

- Batiste Spring (SW14)—4.44 mg/l (Bannock Range hydrogeochemical regime)
- Swanson Road Spring (SW15)—2.64 mg/l (Portneuf River Valley hydrogeochemical regime)
- Spring at the STP (East Side System) (SW13)—3.41 mg/l (Portneuf River Valley hydrogeochemical regime)
- Papoose Spring (SW07)—2.98 mg/l (Bannock Range hydrogeochemical regime)

Note that the STP spring is a Portneuf River Valley hydrogeochemical regime spring that lies on the right bank (east side) of the river. EMF-related groundwater cannot impact this spring.

Mean nitrate concentrations were lower for sampling points in the drainage channels of Batiste Spring (SW11 at 1.99 mg/l) and Papoose Spring (SW06 at 2.14 mg/l and SW05 at 2.15 mg/l). This suggests that nitrate was present in greater concentrations in groundwater discharging to springs than it was in surface water. The 2XSD range for nitrate in low-chloride Bannock Range groundwater is 0.3 to 1.7 mg/l, and for Portneuf River Valley groundwater, 0.9 to 4.3 mg/l.

As nitrate is related to EMF operations as well as to non-EMF activities, the following discussion provides an explanation of relatively higher nitrate levels.

Individual nitrate results for each spring-related sampling point for each round of sampling during Phase I of the RI sampling program are shown in Figure 4.5-10. Nitrate concentrations for the springs in the East Side System are generally above 3 mg/l. Slightly elevated nitrate concentrations were detected at the unnamed spring within the STP operations area (SW13).

The value of 11 mg/l at Batiste Spring for April 1993 may represent a unique or intermittent event that impacted groundwater and, subsequently, Batiste Spring. During April 1993, total phosphorus and sulfate at Batiste Spring were also elevated above levels for previous rounds of sampling (Appendix E).

Figure 4.5-11 presents individual nitrate results for the following river sampling stations for each round of sampling during Phase I of the RI sampling program, as follows:

- The maximum value for losing-reach stations SW25 to SW18
- Losing-reach station SW17
- Losing-reach station SW16
- Gaining-reach station SW12
- Gaining-reach station SW12E (for April 1993 only)
- Gaining-reach station SW10
- Gaining-reach station SW08
- The maximum value for gaining-reach stations SW07E to SW01

Higher mean concentrations of nitrate in springs than in spring drainage and river samples was attributed to nitrate concentrations in groundwater. Nitrate

concentrations were also consistently higher in gaining-reach river water than in losing-reach river water. By definition, the river is being recharged by groundwater in the gaining reach, either directly through the riverbed or indirectly from springs. Groundwater could be identified as a potential source of elevated levels of nitrate in the gaining reach. Representative nitrate levels for Bannock Range groundwater were exceeded in the left bank Wells 503 and 505 (2.3 to 3.9 mg/l).

To the east of the Portneuf River (on the right bank), nitrate in groundwater (3.0 to 3.4 mg/l in Wells 512 and 513) may be related to agricultural activities that are conducted in the Portneuf River floodplain. To the west (left bank) of the river, similar nitrate levels would also be associated with agricultural activities that are conducted in the Portneuf River floodplain and in the Michaud Flats. Mean nitrate concentrations generally decreased along the flowpaths from springs to the river as shown in Figure 4.5-12. The nitrate concentrations in surface water shown in this figure were generally lower than those found in groundwater on the right bank (east) of the river.

River station SW17 had consistently higher concentrations of nitrate than other losing-reach stations (up to 1.62 mg/l in October 1992). SW17 is located at the FMC outfall. Nitrate was found to be present at a concentration of 18.4 mg/l in IWW ditch water during Phase I. Elevated nitrate levels in the river at SW17 could be attributed to the FMC outfall. However, the maximum nitrate concentration found in a Phase II sample (collected at SW 17) was 0.72 mg/l; the mean concentration in the Phase II samples was 0.57 mg/l. Therefore, Phase II results did not confirm Phase I sampling results.

As shown in Figure 4.5-11, for the gaining-reach river sampling stations, the highest nitrate levels for three of four sampling events were detected in samples collected at the downstream stations SW07E to SW01 (maximum value of 2.8J mg/l for SW01). SW01 was the furthest downstream river sampling station in the RI sampling program. During July 1992, nitrate concentrations for SW01 (2.8J mg/l) and the next station upstream, SW03 (2.7J mg/l), were high compared with other gaining-reach stations. These higher nitrate concentrations are consistent with findings from a previous investigation (Perry, 1977).

As described in Section 1.3, water quality sampling conducted by Perry (1977) in 1975 found that the annual mean concentration of nitrate-N was the greatest at stream station 7 (Siphon Bridge Road). This location is the same as SW03 and was the furthest downstream location sampled during the 1975 investigation.

Above-representative levels of nitrates were also found for stations 5E and 5F (see Table 4.5-12), with mean concentrations of 2.47 and 2.56 mg/l, respectively

(representative groundwater levels are 0.3 to 1.7 mg/l). These stations are located directly below the Papoose Springs Fish Farm.

In summary, non-EMF facility activities appear to have enriched nitrates in the groundwater that feeds the gaining reach of the Portneuf River, Batiste Spring, and Papoose Spring. The Papoose Springs Fish Farm also contributes some nitrates to Papoose Springs.

Total Phosphorus. Mean orthophosphate and total phosphorus concentrations were at or near the detection limit (0.03 mg/l) for East Side System springs (SW13 and SW09) and for all but one of the Papoose System spring-related sampling points (SW07, SW06, SW04, and SW02) (see Figures 4.5-13 and 4.5-14). Concentrations at these spring-related sampling points were well within representative groundwater concentrations (0.04 mg/l): orthophosphate – ND to 0.39 and ND to 0.33 mg/l; and total phosphorus – ND to 0.13 mg/l and ND to 0.31 mg/l, respectively.

Mean orthophosphate and total phosphorus concentrations were above or in the upper range of representative groundwater concentrations at four of the 12 spring-related sampling points. Mean orthophosphate concentrations were highest for Batiste Spring (SW14), with orthophosphate at 2.36 mg/l and total phosphorus at 2.71 mg/l. Mean orthophosphate and total phosphorus decreased downstream in the Batiste Spring drainage channel (0.59 and 0.48 mg/l). However, these concentrations were still greater than representative Bannock Range groundwater concentrations of these parameters (orthophosphate: ND to 0.33 mg/l, and total phosphorus, ND to 0.31 mg/l). Mean orthophosphate and total phosphorus concentrations at Swanson Road Spring (SW15) were 0.99 and 1.05 mg/l, respectively, which also exceed representative levels. Total phosphorus is an EMF facilities-related parameter found in groundwater in wells near the Portneuf River. The appearance of total phosphorus in these springs may be attributable to the EMF facilities.

Total phosphorus and orthophosphate concentrations in gaining-reach river stations were higher than in losing-reach stations (see Table 4.5-12), and above representative groundwater levels. The following discussion provides an explanation of the relatively higher total phosphorus (and orthophosphate) levels.

Although concentrations were generally very low in groundwater, total phosphorus was present in groundwater beneath the EMF operations areas. Wells near the left bank of the Portneuf River had elevated levels of total phosphorus that can be attributed to the EMF facilities. Elevated mean total phosphorus concentrations in left bank springs and spring drainage (Batiste Spring 2.71 mg/l, Batiste Springs drainage 0.48 mg/l, and Swanson Road Spring 1.05 mg/l) are readily attributed to the

EMF facilities. All other spring-related sampling points except SW05 had mean total phosphorus concentrations less than 0.10 mg/l. However, Batiste Spring and Swanson Road Spring did not appear to be a major source of total phosphorus in the gaining reach of the river.

Relatively high mean total phosphorus concentrations (0.22 mg/l) were found at the point where Papoose Spring discharges to the Portneuf River (SW05). This sampling point is downstream of the Papoose Springs Fish Farm. As total phosphorus parameters were not elevated in the spring (SW07) and spring drainage (SW06) above the fish farm, the total phosphorus at SW05 is attributed to the enriched nutrients associated with the fish farm.

Individual total phosphorus results for each spring-related sampling point and for river sampling stations, respectively, for each round of sampling during Phase I of the RI sampling program are indicated in Figures 4.5-15 and 4.5-16. These figures show that total phosphorus concentrations in the gaining reach of the Portneuf River were consistently highest at SW12. This river sampling station is located at the STP discharge and is upstream from where the Batiste System discharges into the river.

As described in Section 1.3, water quality sampling conducted by Perry (1977) in 1975 found that Pocatello STP effluent had much higher concentrations of total phosphorus (8.2 mg/l) compared to other effluents measured (approximately 0.3 mg/l). It is likely that elevated total phosphorus concentrations in the gaining reach of the Portneuf River were primarily the result of discharge from the STP and the Papoose Springs Fish Farm and not from groundwater impacted by the EMF facilities.

Losing-reach sampling station SW17 had total phosphorus concentrations (0.64 mg/l) above those at the gaining-reach river sampling stations (Table 4.5-13). A source contributing flow to station SW17 was the FMC outfall. In Phase I, the total concentration in this ditch water was 2,590 mg/l. The total phosphorus concentration measured at station SW17 (0.64 mg/l) was likely attributable to the outfall. Subsequent Phase II sampling conducted at SW17 showed mean total phosphorus concentrations of 0.14 mg/l, much lower than the Phase I findings (Table 4.5-2).

Even though the total phosphorus detected during Phase I in the IWW ditch was elevated, the impact of this discharge was very localized, and decreased rapidly between station SW17 and the next downstream sampling station (SW16). As shown in Figure 4.5-16, station SW16 is also in the losing reach of the river. For the first three sampling events, total phosphorus concentrations in the first gaining-

reach station below SW16 (SW12) rose sharply indicating another source of total phosphorus downstream of SW17 and SW16. For the April 1993 sampling event, SW12E was also sampled. This station is located between SW16 and SW12 on the river. Total phosphorus was higher at SW12E (a gaining river station) than at SW16, but was much less than at SW12 (STP discharge).

The increase of total phosphorus in river water between stations SW12E and SW12 is further support that the STP discharge was the main source of elevated total phosphorus in the gaining reach of the Portneuf River.

Fluoride. Mean fluoride for all 12 spring-related sampling points was within the range of 0.3 to 0.8 mg/l (Table 4.5-12). Representative groundwater concentrations of fluoride were within the range of 0.003 to 0.7 mg/l for Bannock Range groundwater, and 0.1 to 0.4 mg/l for Portneuf River Valley groundwater. Two springs were at or exceeded this representative groundwater range: Siphon Road Spring (SW04, 0.8 mg/l) and Twenty Spring (SW02, 0.7 mg/l). Based on a common ion and physical parameter analysis, these two springs have not shown any EMF facilities-related impacts. Historical analysis of fluoride in springs (Perry et al., 1990) indicated that the Papoose System springs generally had higher fluoride than springs in the systems closer to the EMF facilities. With the exception of river sampling station SW17, fluoride concentrations in surface water were within those found in the representative groundwater.

In characterizing the spring groups, Perry et al. (1990) found fluoride concentrations to be significant. Historically (from 1978 to 1980), fluoride concentrations were four to five times greater (1.32 mg/l) in the Papoose System (called Group IV by Perry) compared with fluoride concentrations in the other three spring groups (0.30 to 0.44 mg/l). In the current sampling program, the highest mean fluoride concentrations (0.7 and 0.8 mg/l) were still found in Papoose System springs (Twenty Springs-East and Siphon Road, respectively). The two East Side System springs (near the STP and the spring-fed pond at FMC Park) still had fluoride concentrations in the 0.30 to 0.44 mg/l range. However, mean fluoride concentrations for the Batiste System (0.6 mg/l) and Perry's Swanson Road System (0.5 mg/l) were greater than the historical means for these groups and were comparable to fluoride concentrations (0.5 and 0.6 mg/l) at the three Papoose System springs-related sampling points (SW07, SW06, and SW05).

Information on fluoride concentrations at Batiste Spring was collected from FMC and Simplot facility files for the period of 1944 through 1990. To prepare Figure 4.5-17, this information was combined with data on fluoride concentrations collected during the RCRA and RI sampling programs (1990 through 1993). Figure 4.5-17 shows that fluoride concentrations have varied greatly over this

period. From 1944 through 1966, mean fluoride concentrations were between 0.7 and 1.57 mg/l. From 1968 through 1984, mean concentrations were between 0.34 and 0.5 mg/l, consistent with the mean concentration for fluoride (0.44 mg/l) calculated by Perry et al. (1990) using data for 1978 to 1980. From 1985 to 1991, the data (Figure 4.5-18) show mean concentrations increasing slightly to concentrations between 0.4 and 0.6 mg/l. Current RI sampling data (1992 to 1993) show a mean fluoride concentration of 0.6 mg/l for Batiste Spring. Although this concentration was higher than the historical system mean calculated by Perry, it is consistent with an increase in fluoride concentrations which occurred after Perry's sampling events.

Both losing- and gaining-reach river sampling stations had fluoride concentrations below 0.5 mg/l except for Phase I SW17 (generally 0.7 mg/l).

SW17 is located at the FMC outfall. Fluoride was found to be present at a concentration of 61.6 mg/l in IWW ditch water during Phase I. Based on Phase I findings, elevated fluoride levels in the river at SW17 could be attributed to the FMC outfall. However, subsequent Phase II sampling conducted at SW17 did not confirm the presence of fluoride (mean concentration was 0.3 mg/l) at Phase I levels during the time of sampling (see Table 4.5-2 and Table 4.5-3A).

Sulfate. Sulfate is a naturally occurring common ion in groundwater and in surface water. For most surface water sampling points, sulfate concentrations were comparable to representative groundwater concentrations of sulfate in groundwater. However, some surface water sampling points had relatively higher sulfate concentrations than others. As sulfate is part of the processes at the EMF facilities, the following discussion provides an explanation of relatively higher sulfate levels in surface water.

As indicated in Section 3.2, higher mean concentrations of sulfate in Swanson Road Spring and in Batiste Spring were attributed to sulfate concentrations in groundwater. Sulfate concentrations were also consistently higher in gaining-reach river water than in losing-reach river water. By definition, the river is being recharged by groundwater in the gaining reach, either directly through the riverbed or indirectly from springs. Elevated levels of sulfate in groundwater could also have been the source of elevated levels of sulfate in the gaining reach.

Figures 4.5-18 and 4.5-19 present individual sulfate results for each spring-related sampling point and for river sampling stations, respectively, for each round of sampling during Phase I of the RI sampling program (except for SW12E, which was sampled in April 1993 only). These figures show that sulfate concentrations in the gaining reach of the Portneuf River were generally highest at SW12 (mean concentration of 70 mg/l) (Figure 4.5-19). This river sampling station is located at

the STP discharge and is upstream from where the Batiste System discharges into the river. The STP likely contributed to elevated levels of sulfate in the gaining reach of the Portneuf River.

As seen in Figure 4.5-19, river sampling station SW17 had generally higher sulfate concentrations than other losing-reach river sampling stations. Sulfate was present at a concentration of 8,400 mg/l in IWW ditch water during Phase I. However, Phase II sampling indicated a mean sulfate concentration of 35 mg/l at SW17, significantly lower than the Phase I SW17 mean sulfate concentration of 65 mg/l. The Phase II results show that sulfate levels at that time were comparable to other losing-reach river sampling stations.

Sulfate entering the river at the FMC outfall was not impacting the downstream gaining-reach river sampling stations. Figure 4.5-19 shows that, for each sampling event, sulfate concentrations decreased rapidly from Phase I SW17 to SW16 in the losing reach. For the first three sampling events, sulfate concentrations in the first gaining-reach station below SW16 (SW12) rose sharply indicating another source of sulfate downstream of SW17 and SW16. For the April 1993 sampling event, SW12E was also sampled. This station is located between SW16 and SW12 on the river. Sulfate was higher at SW12E than at SW16, but was much less than at SW12 (STP discharge).

The pattern of sulfate distribution downstream of SW17 is the same as for total phosphorus. This suggests that the STP discharge was a major source of elevated sulfate as well as total phosphorus in the gaining reach of the Portneuf River.

4.5.3 Characterization of Constituents of Potential Concern in Surface Water Sediment

This section describes trace metal, nutrient, and radiological parameters detected in surface water sediment samples collected during the RI sampling program. Sediment samples were taken for constituent analysis from the Portneuf River at 21 different locations (see Figure 2.5-1). These locations extended from above the City of Pocatello (location SD25) to the Portneuf River Bottoms (Fort Hall Bottoms) near the American Falls Reservoir (SDC1, SDC2, SDC4). Sediment samples were taken for constituent analysis from contributing springs and their reaches at nine locations.

In evaluating whether there has been an impact on the river sediments by the industrial operations at the EMF facilities, three comparisons were made. The first was to consider how the downstream sediments compare with those taken at sampling points unlikely to be influenced by site activities. These uninfluenced

points are upstream river sample locations SD22 through SD25 and SDA1 and SDA2 (Figure 2.5-1).

Second, the concentrations of parameters detected in the sediments were compared to both surface and subsurface soil representative levels (i.e., if the sediments are locally derived, they should be comparable to local soil compositions with some potential for leaching). Since upstream (where soils may not be comparable to EMF representative soils) sediment loading and downstream redeposition of these sediments is possible, this was not a strictly direct comparison (i.e., river, though not spring, sediments could be different from EMF study area soils), and there may be some unaccountable variability. However, this comparison provides some guidelines for evaluation.

Finally, as has been demonstrated in the onsite and offsite soil sections of this report, the EMF byproduct and feedstock sources can be readily recognized by their inorganic constituent content. For above-representative constituents in a sediment sample to be attributable to particulate matter from the EMF facilities, they would likely contain or be associated with above-representative levels of cadmium, chromium, zinc, vanadium, fluoride, and total phosphorus. This is because all of these constituents are part of the various site particulate matrices and have little tendency to leach under normal (6 to 8) pH ranges. This suite of characteristic constituents was used in evaluating potential site impacts on sediment quality.

A previous investigation (Mazanowski, 1992) attempted to quantify four heavy metals (cadmium, copper, lead, and zinc) associated with the clay-silt fraction of sediment from the Portneuf River. The investigation concluded that, with the exception of cadmium, there was no difference between sediment metal concentrations between "rural" and "urban-industrial" portions of the river. Eight of 27 sampling locations were in the EMF study area. Two locations, Batiste Lane Bridge and West Siphon Road Bridge, are downstream of the EMF operations areas. For the samples taken at these two locations, cadmium, copper, and zinc concentrations were elevated above the calculated mean concentrations for that investigation. The maximum cadmium concentration detected (14.9 mg/kg) during the Mazanowski (1992) investigation was for the sample collected at Batiste Bridge, with the second highest concentration found at Siphon Road Bridge (6.2 mg/kg). The copper concentration in the sample from the Batiste Lane Bridge location (40 mg/kg) was above the calculated mean for that investigation. It should be noted, however, that the study performed by Mazanowski was an undergraduate student study of limited scope. Because information on analytical methods and quality assurance and quality control procedures used in the study are not available, the accuracy of the data reported cannot be assessed.

Section 4 Nature and Extent of Constituents of Potential Concern

An evaluation of the chemical analyses of the sediment samples and their location with regard to river and spring geometry and sediment deposition characteristics led to the following conclusions:

- Constituents attributable directly to EMF industrial operations are found only in the vicinity of the currently operating FMC outfall (location SD17) (see Figures 4.5-20 through 4.5-23). Characteristic constituents are cadmium, fluoride, vanadium, zinc, and total phosphorus.
- The sediment sampling locations selected along the Portneuf River are appropriate sites to detect the impact of past releases from the EMF facilities on sediment quality.
- No above-average river sediment or above soil representative average concentrations of trace metals were detected in the three samples taken at the Portneuf River Bottoms area near the American Falls Reservoir.
- No PCBs were detected in any of the samples tested.
- The only observed impact on Portneuf River sediments in the Fort Hall Bottoms, as indicated by the three samples taken in that reach of the Portneuf River, that can be attributed to anthropogenic activities would appear to be enriched levels of phosphates. Non-EMF sources (e.g., fish farms) are probable.
- Overland flow in the EMF study area does not appear to contribute sediment loading in the Portneuf River. This conclusion is reached through an analysis of total aluminum loading and the lack of a measurable difference between sediments in areas where the bank soils contain trace metals, total phosphorus, and fluoride significantly above-representative levels and sediments that do not. It is also reached through analysis of stormwater runoff described in Section 3.2.2.
- Precipitation of constituents of interest from influent groundwater does not appear to be occurring in a measurable fashion.
- Deposition of particulate or gaseous compounds into the surface waters with a resultant enrichment of sediment is not occurring at a measurable rate.
- Gross alpha and gross beta activities were higher in spring sediments than river sediments. This is likely because spring sediments are locally derived from the vicinity of the spring and river sediments are not, as demonstrated by comparable levels of gross alpha and gross beta found in spring sediments and representative soils.

Supporting documentation for these conclusions is provided in the following sections. Section 4.5.3 is organized into the following subsections:

- Section 4.5.3.1 describes sediment deposition patterns in the Portneuf River.
- Section 4.5.3.2 discusses the metals and nutrients in river sediment samples; while Section 4.5.3.3 discusses the radiological parameters detected in river water samples.
- Sections 4.5.3.4 and 4.5.3.5 discuss the metal and nutrients and radioactive parameters in spring sediments.
- Section 4.5.3.6 presents the nature and extent of site-related parameters in river and spring surface water sediments.

4.5.3.1 Sediment Deposition in the Portneuf River

The Portneuf River has its headwaters in the Portneuf Range approximately 20 miles (11 km) from the City of Pocatello. In the EMF study area, it runs briefly by the Bannock foothills (from sampling stations SD25 to SD22) before emerging onto the Michaud Flats. From sampling station SD22 north to sampling station SD1, the surrounding area can be characterized as relatively flat steppe. Sampling stations along the Portneuf River are shown in Figure 2.5-1.

In general, the river from Pocatello to the Fort Hall Bottoms is a narrow (30 to 80 feet [approximately 9 to 25 m]), low-energy, moderate to highly sinuous, meandering surface water body with depth-to-width ratios of 5 to 30. The river between sampling station SD25 and I-86 is believed to be losing. That is to say, the groundwater surface is below the bottom of the river and cannot contribute flow to it. Below (north of) I-86, the river increases dramatically in flow volume as its bottom intercepts the highly transmissive Portneuf River Valley aquifer's saturated Michaud Gravel. In addition, as discussed in Section 3.2 and Appendix A, numerous springs begin to appear at this point.

In *Terrigenous Clastic Depositional Systems*, Galloway and Hobday (1983) present a series of descriptions for the expected depositional behavior of various riverine systems (pp. 51-79). There are three systems presented: bed-load channels, mixed-load channels, and suspended-load channels (Figure 3.2-2). As discussed in Section 3.2.1.2, the Portneuf falls between the mixed- and suspended-load models. The mixed-load model is a sinuous, moderate-energy river capable of transporting both fines and sands. The suspended-load channel is highly sinuous and low-energy and transports primarily fines. The description of the bed of the suspended-load system more closely fits the Portneuf River as it has steep silt or clay banks with a scoured channel and depositional deposits near the banks. In the float conducted in September 1993, it was noted that the main channel area was primarily gravel and cobbles with little sediment present. However, the areas towards the banks did

have sediment present and did support macrophytes. In addition, the depth-to-stream width fits the description of a suspended channel system as having a low depth-to-width ratio. The bed-load channel (which Jimmy Drinks at its mouth appears to be) has a very high depth-to-width ratio (40:1 or more). In other words, in a fairly low-energy sinuous system it is expected that sedimentation will occur along the banks of the stream (Figure 2-4). It is in these areas that sediments were found and sampled during the Portneuf River investigation. They are representative of river deposition in the area in which they were taken.

There is a distinct break in river character and vegetation as the Bottoms area is entered. The vegetation is less capable of preventing erosion and the presence of eroded bank sediments in the main channel area is noticeable. There was stressed vegetation in this area. This stress was attributed (communication with Gary Fenwick, Shoshone-Bannock Tribe Superfund Coordinator) to the fact that this part of the Bottoms area is inundated during the spring by the flooding of the American Falls Reservoir. This floodwash would explain the eroded nature of the surrounding terrain and the fact that the river bottom, even in its main channel was covered by sediments other than Michaud gravels as is the case further upstream. This flooding could bring with it sediments introduced by the Snake River and other contributing bodies as well as causing some erosion during drainage into the extant channels (the Portneuf River being one). Hence, sediment loading in the Bottoms area occurs primarily during spring thaw and is the result of the flooding of the American Falls Reservoir. The fact that there is a large mixing of American Falls Reservoir sediments with sediments from the surrounding uplands, as well as those making their way down from upriver, would make this area of the Portneuf River a highly unlikely location to sample for materials originating solely from upstream. The presence of fines, even in the main channel of the Portneuf River, is further evidence of its low-energy nature and the high loading from bank erosion.

Shallow sediments in the Portneuf River near the EMF facilities can have several potential sources. These would include redeposition from upstream sources; erosion of nearby banks and overland flow during precipitation or snowmelt events; windblown deposition of particulates and gaseous compounds; as well as potential suspended solid deposition from commercial discharges (e.g., FMC and the STP). While the springs that are examined in this investigation do not have discharges in their reaches, they are subject to other commercial activities such as the fish farms and the creamery operations. A less likely, but potential, additional source would be precipitation of constituents found in the groundwater when it discharges into the springs or river due to changes in chemical equilibrium.

The character of the springs and their reaches differ markedly in quality and potential for sediment loading. For example, Batiste Spring flows directly into a several-hundred-yards-long reach with a narrow natural channel and rocky bottom. Other springs emerge right at the Portneuf River with little to no reach while springs like Papoose at the fish farm and the one at the FMC park form a pond before overflowing into long narrow reaches. Further downstream, Jimmy Drinks is a wide, shallow, relatively high-energy water body having a very rocky bottom as it enters the Portneuf. These springs have differing potentials for contributing sediment load to the Portneuf River.

Sediments that are present in the Portneuf River above the Bottoms are more likely to be fines and to have been transported from areas to the south where there is more topographic relief. The primary time of transport would be during spring runoff when snowpack waters combine with fines to enter the river in the south.

This theory can be tested by comparing the various values of dissolved and total aluminum observed at the sampling stations during the quarters tested. Aluminum is an excellent candidate for this as it is a major natural component of clay and silt matrices, and its presence in the "total" samples, compared with the dissolved fraction, serves as an indicator of the presence of fines in the water.

There is a marked difference between the aluminum concentrations found from the July/August and October 1992 and February 1993 surface water sampling during the RI, and April 1993 (Figure 4.5-5). The former represent low-flow, low-precipitation/runoff opportunities while the latter is during spring thaw. The difference is up to a factor of four with the upstream values being twice that of the downstream. This difference between upstream and downstream is probably due to the infusion of groundwater, spring water, and the STP discharge rather than a settling out of the fines at the downstream stations. However, it should be noted that the springs and their reaches do not exhibit a high aluminum value during the April event, which indicates that there is little overland flow of sediment to them occurring in the same drainage area of the Portneuf River. In fact, for the areas near Batiste and Papoose springs, runoff from upland areas would have to cross the spring reaches to reach the Portneuf River. The absence of elevated aluminum here would suggest that these stretches of the Portneuf River were not receiving significant, local sediment loading at the time of sampling.

4.5.3.2 Metals and Nutrients Detected in River Sediment Samples

Sediment samples were taken at six upstream locations during Phase I and Phase II (Figure 2.5-1). Of these, five have clayey textures (SD24, SD23, SD22, SDA1, and

SDA2), and one (SD25) is a clayey sand. When making between-sediment comparisons, it is always necessary to ensure that like textures are being compared because natural mineralogies (and hence the type and amount of constituents present) will differ with texture. A comparison of the results for the upstream samples with soil representative values indicates some enrichment for lead in samples taken from SD24 (51.6 mg/kg) and SD23 (71.9 mg/kg). These were the highest levels of lead detected in any of the sediment samples. There is also moderate enrichment of mercury in sediment taken from sample location SDA1 (0.55 mg/kg). Zinc was above representative soil levels at sample location SDA1 (55.3 mg/kg) and near the upper bound at sample location SDA2 (50.3 mg/kg). Finally, fluoride was above representative soil values at sample location SD23 (1,300 mg/kg). All other parameter results were within the range for representative soils (Tables 4.5-14 and 4.5-15).

Location SD21 sediment was taken approximately 1,000 feet downstream from sample location SD22. It is silt and sand and is located just to the northeast of the Simplot lower gypsum stack. A comparison of the parameter results found at this location with those results in upstream samples indicates similar but generally lower concentrations of the parameters tested for (Table 4.5-14). All the results are also within the representative soil range and the EMF characteristic metals are not present in elevated quantities. This location has not been impacted by EMF facilities activities.

Location SD20 sediment was taken approximately 1,800 feet downstream from SD21 (Figure 2.5-1). It is a sand. A comparison of the parameter results found at this location with those results in the upstream samples indicates similar but generally lower concentrations of the parameters tested for (Table 4.5-14). This is expected since it is a sand rather than a clay and less likely to have naturally occurring trace metals in its matrix or contain adsorbed metals. The one exception to this trend is lead, which at 61.0 mg/kg is higher than would be expected. With the exception of lead, all the results are within the representative soil range and the EMF characteristic metals are not present in elevated quantities. This location has not been impacted by EMF facilities activities.

Location SD19 sediment was taken approximately 1,000 feet downstream from SD20 (Figure 2.5-1). It is a silty clay. A comparison of the parameter results found at this location with results from upstream samples indicates there are similar concentrations of most metals tested for. The exceptions, lead and chromium, are somewhat higher (Table 4.5-14). However, the results, including lead and chromium, are within the representative soil range and the EMF characteristic metals are not present in elevated quantities nor are total phosphorus or fluoride. This location does not show EMF facility impact.

Two surface soil samples (90-1D and 90-1C) were also taken in the general area of sample locations SD20 and SD21. They both contain the suite of constituents characteristic of particulates at the EMF facilities (Tables 4.5-14 and 4.5-15). However, as was shown above, the sediment locations that could be influenced by runoff deposition from these enriched surface soils do not contain a similar suite of constituents. This observation indicates that runoff did not contribute to river sediment loading in a measurable fashion. As indicated in the sedimentation process section above and in Section 3.2, this is an expected result given the low slope factor, the presence of vegetation, and low precipitation. In other words, there is no chemical imprint in river sediments adjacent to an area of impacted upland soils. This is consistent with observations of no subsurface runoff from the facility and calculations showing that storm runoff is contained on the site (see Section 3.2).

Location SD18 is near the old FMC and Simplot outfalls. It is approximately 350 feet downstream from SD19. The texture of the sediment sampled was sand with gravel. While arsenic was on the high end of the representative spectrum (8.4 mg/kg), the remaining parameters that were tested for were below both representative and upstream trace metal levels (Table 4.5-14). This result is not unexpected for the trace metals since the sands, unless their matrix derives from a metal-containing rock, are not generally high in metals nor given to adsorption.

Sample location SD17 is located several feet out and downstream of the current FMC outfall. Its sediment texture was a sandy clay. When dried, the material contained a gray, claylike material with shell and rock fragments. The sandy fraction appeared to be coarse, pink and purple sand, probably of volcanic origin. Also, there was considerable vegetative matter that made up a matrix within which the sediments were contained. The chemical analysis of this sediment sample revealed a number of parameters that were above-representative soil levels. Also, this sample contained the suite of constituents characteristic of particulate sources within the FMC facility (Tables 4.5-14 and 4.5-15) and, therefore, is considered to be related to FMC industrial activities. A sample of the sediment was made into a thin section and compared with thin sections of slag, phosphate ore, and precipitator slurry. The visual microscopic comparison indicated that the sediment sample did contain components of precipitator dust and ore. The presence of ore is not surprising since the IWW ditch runs just to the east of the FMC ore pile. The evaluation report, complete with color slides of the thin section, is presented in Appendix N.

During Phase II, three additional samples were gathered in the vicinity of the FMC outfall (Figure 2.5-1). These samples were taken in July 1993 (see Figure 4.5-24 for the location of all three samples). Sample 17A was collected directly in front of the

FMC outfall pipe. FMC had placed a steel plate in front of the pipe to act as a baffle, and the sample had to be taken behind it. Sampling in front of the pipe was not possible because there was very little space between the plate and the outfall pipe, and the river bottom area had been thoroughly scoured. The texture of the sample taken from this area was a sandy gravel. Even though the sample was a sandy gravel, it contained above-representative levels of various parameters and had the suite of EMF characteristic constituents (Table 4.5-16) indicating EMF facilities-related particulates. Sample 17B was taken downstream on the eastern side of the river (the channel runs to the west). Its texture was a fine sand with some shell fragments. All parameters, with the exception of calcium, were below both representative soil and upstream levels. The high calcium level was probably due to the dissolution of the shells during sample preparation. Sample 17C was taken on the east border of the river approximately 70 feet (22 m) downstream from the outfall pipe. Its texture was moderate to fine sand with shell fragments. All parameters for samples 17B and 17C, with the exception of calcium, were below representative soil levels, and there was no evidence of the EMF characteristic constituents.

The sampling that has been carried out in the area of the FMC outfall indicates that there was a very localized impact on river sediments around the outfall mouth. Samples collected in the downstream portion of this area and at points further north (downstream) did not have the EMF characteristic constituents and, hence, verify that there has been no measurable impact beyond the outfall.

River sample location SD16 is located just to the north of I-86 and Batiste Road, an area subject to runoff from the freeway and the road. The sediment sample was taken on the eastern side of the river. Its texture was silty clay. Copper (30.8 mg/kg) and zinc (56.9 mg/kg) were detected in the sample at above representative soil values (Tables 4.5-14 and 4.5-15). In addition, chromium (23.8 mg/kg) was found at the upper end of the representative range (26.9 mg/kg). The remaining parameters were well within the range of representative soils and upstream sediment values. While these three metals could be associated with EMF activities, the absence of cadmium and the low values detected for fluoride (273 mg/kg) and total phosphorus (554 mg/kg) indicate that they are not related to the EMF facilities. Rather, the presence of metals may be related to runoff from the freeway.

Location SD12 is located 80 feet (24 m) downstream from the STP discharge. Sediment sampled here was taken on the deposition (west) side of the channel. Its texture was sand. An evaluation of the analytical results shows that all parameters were within both the representative soil range and upstream sediment sample values (Tables 4.5-14 and 4.5-15). It should be noted that, given the geometry of the

river at this location, SD12 is probably not an area where deposition from the STP discharge would occur.

Sample location SD10 is in the river just downstream from the mouth of Batiste Spring. The texture of the sample taken here was fine sand. All analytical results were well within both the representative soil and upstream sample ranges (Tables 4.5-14 and 4.5-15). The single exception was total phosphorus, which had a value of 7,150 mg/kg. An examination of the river geometry indicates that this is a depositional area for both Batiste Spring and the STP. STP effluents are rich in phosphates. The higher phosphate levels were not present at sample point SD12, which is not in a position to receive STP deposition, but is in a position where it could have been impacted by the EMF facilities in the event of a release. Also, this station is downstream from the fish farm located on the Batiste Spring reach, which could also be responsible for some phosphate deposition in the sediments.

Sediment sampling location SD08 is at the mouth of the spring-fed pond at the FMC park. The texture of the sample is loam, with considerably more fines than sand. Arsenic was detected (9.9 mg/kg) in this sample at above representative soil levels. Lead was also above the representative mean (19.2 mg/kg). Neither of these elements is regarded as indicative of the EMF particulate matrix, and the EMF characteristic constituents (cadmium, chromium, vanadium, zinc, fluoride, and total phosphorus) are all within the representative soil range (Tables 4.5-14 and 4.5-15). This observation indicates there is a different source for these two elements.

Sediment sampled at location SD03 was taken in the river at the bridge at Siphon Road (Figure 2.5-1). Its texture was layered loam with sand and gravel. The aluminum value indicates that the actual sample tested was more sandy than silt/clay. None of the parameters tested for were above the representative soil range; they were below the values found in the upstream samples (Tables 4.5-14 and 4.5-15).

Sediment sampled at location SD01 was taken at river mile 10 (Tables 4.5-14 and 4.5-15). Its texture was loam. The only parameter that was elevated was silver (2.1 mg/kg). The remainder of the parameters tested for were within the representative soil range and generally below those values found in the upstream samples.

Location SDB1 sediment was collected at a public boat launching area in the Fort Hall Bottoms and above the high water mark of the American Falls Reservoir (Figure 4.5-25). Its texture was silty clay. This sample contained numerous parameters that were above representative soil levels although not necessarily above values found in the samples upstream of the EMF facilities (Tables 4.5-14 and 4.5-15). Also, the EMF characteristic constituents were not all present. The lack of

elevated levels of vanadium, cadmium, total phosphorus, and fluoride indicates the absence of EMF facilities-related particulates. The presence of trace metals above the representative soil range, such as lead (30.9 mg/kg), copper (25.5 mg/kg), mercury (1.1 mg/kg), and zinc (97.1 mg/kg), may be attributed to the use of the area as a recreational boating launching area, combined with the presence of very high levels of aluminum (16,200 mg/kg), iron (16,100 mg/kg), and total organic carbon (11,074 mg/kg) in the soil matrix. The first two of these latter constituents reflect the high clay content of this sediment. This content, combined with the high organic content, imply a potential for high adsorption/absorption abilities by the soil matrix.

Sediment sample SDC1 was taken on the downstream side of a point bar. Its texture was silt with fine sands (see Figure 4.5-25). With the exception of calcium (166,000 mg/kg) and total phosphorus (1,160 mg/kg), all parameters tested for were below the representative range and, in general, below that seen in the upstream samples (Tables 4.5-14 and 4.5-15).

River sediment was sampled at location SDC2, approximately 1,000 yards downstream from SDC1 (Figure 4.5-25). Its texture was silty clay. With the exception of calcium (88,500 mg/kg), all parameters tested for were within the representative soil range (Tables 4.5-14 and 4.5-15). As with sediment sampled at SDC1, the EMF characteristic constituent suite was absent.

The last downstream sediment sample to be taken was at location SDC4. This sample was collected at a point approximately 400 feet downstream from location SDC2 (Figure 4.5-25). Its texture is described as a clayey silt. As with sample SDC1, calcium (93,200 mg/kg) and total phosphorus (1,060 mg/kg) were the only parameters detected above the representative soil range. Total organic carbon was also in the high range of the samples tested (9,468 mg/kg).

4.5.3.3 *Radioactive Constituents of River Sediments*

Gross alpha and gross beta were measured on all sediment samples taken during the investigation. Offsite soil samples were not measured, and, hence, there is no opportunity for comparison with representative soils. Therefore, a comparison of upstream versus downstream is used.

Gross alpha values ranged from 6.33 ± 2.96 pCi/g (SDA2) to 13.6 ± 1.28 pCi/g (SD23) in the upstream samples (Table 4.5-17). The highest gross alpha concentration was found at location SD17, the FMC outfall. This observation is to be expected since, as has been shown in the potential source data, the EMF particulate matrices contain gross alpha concentrations that are higher than onsite soils. Since the inorganic

analyses also indicate that this area has EMF-characteristic constituents, this is corroborative evidence.

When SD17 sediment is set aside, the downstream sediment stations from SD21 to SDC4 all had 12 pCi/g or less gross alpha, which is less than or similar to the values found upstream. Even SDB1, which contains a considerable number of above-representative soil constituents, but not those characteristic of EMF potential sources, is relatively low at 8.15 ± 3.33 pCi/g. This observation is a further indication that the above-representative inorganic parameters found at this location were not EMF facilities-related.

In summary, the sediments responsible for the gross alpha values observed at SD17 do not appear to have been transported downstream. In addition, the lack of elevated gross alpha readings in river sediments at locations other than SD17 suggest that soils in the EMF study area that contain EMF facilities-related matrices (and, hence, should also contain gross alpha emitting constituents) have not migrated into the river sediments. This supports the conclusion drawn for the EMF facilities-related inorganics that there has been no measurable influence by overland flow that has contributed to sediment loading in the study area.

In examining gross beta values, it should be kept in mind that potassium-40 can be a major contributor to this value. Potassium is generally a major component of natural clay soils and, as has been demonstrated in several of the previous sections of this report, it is a major component of several EMF potential sources. However, as can be seen from the data collected for the sediments (Table 4.5-17), gross beta and potassium-40 values are not always congruent, indicating another unidentified beta-emitting source.

Upstream gross beta values ranged from 10.2 ± 2.62 pCi/g (SDA1) to 25.3 ± 1.45 pCi/g (SD24). These values reflect the silty/clayey nature of the sediments. The highest value found in all the samples was at SD17, where 30 ± 3.15 pCi/g gross beta was detected. This observation is to be expected since this sediment sample has been identified as containing EMF facilities-related particulates.

Sediment samples collected downstream of SD22, excepting SD17, had gross beta values ranging from nondetect at 5 pCi/g for SDC1 to 16.9 ± 2.35 for SD19. These values show the same pattern as do inorganics and gross alpha insofar as they demonstrate that EMF facilities-related parameters are confined to location SD17.

4.5.3.4 Metal and Nutrient Detection in Spring Sediments

Nine sediment samples were collected from seven springs and their reaches during the RI. As has been explained above in the surface water section, these springs are fed by two different subsurface systems. Stations SD15, SD13, and SD09 are related to the Portneuf River Valley hydrogeochemical regime. The remaining stations (SD14, SD11, SD07, SD05, SD04, and SD02) are related to the Bannock Range regime.

In the groundwater section of this report, it was demonstrated that because of the dynamics of the local flow regime, subsurface water that has been impacted by site industrial activities is only likely to enter the surface water system through Swanson Road and Batiste springs. Hence, it will be necessary here to also examine the constituents found in the sediments for precipitation products and the potential accumulation by bottom-growing plants.

The examination of the groundwater data in Section 4.4 shows that there is a set of constituents found dissolved in groundwater beneath various portions of the EMF facilities. These chemicals are arsenic, barium, boron, chloride, cobalt, copper, fluoride, lithium, magnesium, manganese, phosphate, potassium, selenium, sodium, sulfate, and vanadium. With the exception of arsenic, cobalt, and selenium, these elements are found in representative subsurface soils at values above 10 mg/kg, which makes it difficult to determine if their presence in groundwater is attributable to their presence in native soils or whether they have been enriched through releases from potential sources at the EMF facilities.

One sediment sample was collected from Swanson Road Spring (see Figure 2.5-1 for the location). Its texture was sand with silt. An examination of the analytical results shows that there were above-representative soil levels of manganese (405 mg/kg) and total phosphorus (955 mg/kg). The remaining parameters are all within the expected representative soil range, and there is no indication of the presence of the suite of constituents characteristic of EMF potential sources. The enriched manganese and total phosphorus values may be a result of EMF facility releases. However, manganese has a tendency to be mobile only in reduced or low pH regimes and should have precipitated out in the oxidized Portneuf water regime before reaching the surface. In addition, as will be shown below, sediments from the Batiste System, whose water component shows facility impacts, have below-average total phosphorus values and are low in manganese. This lack of correlation would tend to argue against the enriched manganese and total phosphorus values at this station being EMF facilities-related.

Sediment sample locations SD14 and SD11 are in the Batiste System. Sample location SD14 is located just north of the Batiste pumping station. Sediment sampled at location SD11 was taken in a ponded area north of the Rowland

creamery buildings (Figure 2.5-1). The texture of the sample from SD14 was sand and gravel. The texture of sediment from SD11 was clayey sandy gravel. Comparing these two samples as well as with representative soil values (Table 4.5-18) shows an enrichment of aluminum and copper in sediment from SD14 (8,230 mg/kg and 13 mg/kg) relative to that from SD11 (3,350 mg/kg and 6.8 mg/kg). This observation may be attributable to the fact that the relatively old and large pumping house at Batiste Spring has a very weathered aluminum/copper alloy roof. In addition, SD14 sediments had above-representative values of lead (29.5 mg/kg) and barium (324 mg/kg), while sediments in SD11 had an above-representative value of zinc (107 mg/kg). Neither of the Batiste System station sediments contained the suite of constituents characteristic of EMF potential sources.

The sample from SD11 was not collected in the main Batiste channel, but rather in a low-energy pool that is still within the area where surface soils have been enriched by aerial deposition of EMF facilities-related particulate or gases. (See offsite soil samples SS45-1C and SS023-1C, Table 4.3-1.) While the surface soil samples contain the suite of EMF characteristic constituents, the sediment sample from SD11 does not. Since they are not evident in the sediment, the conclusion can be drawn that air deposition is not an important route for sediment impact, even at an area of relatively quiescent surface water.

Spring sediment sampling station SD13 is located to the east of the Portneuf River. Its reach lies between the Portneuf River and the STP sewage sludge drying beds. The texture of the sample was sand. An examination of the analytical results for SD13 sediment (Tables 4.5-18 and 4.5-19) shows above-representative values for total phosphorus (3,950 mg/kg), fluoride (800 mg/kg), and cadmium (1.4 mg/kg). Also, SD13 sediment was the only spring sediment to have detectable levels of selenium (3.5 mg/kg), and the lead value, while within representative range, was above the mean (24.7 mg/kg). The groundwater flowing into this spring is from the Portneuf River Valley regime and is not influenced by EMF facilities activities (see Section 4.4.2); hence, precipitation of EMF facilities-related constituents would not be a factor. The lack of enriched values of chromium, vanadium, and zinc in the sediment sample would argue against it containing EMF facilities-related particulate. The most probable source for the elevated constituents may be the sludge drying beds.

Sediment sampled at location SD9 was taken at the spring-fed pond at the FMC park. As with the spring at SD13, this spring is also fed by the Portneuf River Valley hydrogeochemical regime and is uninfluenced by EMF facilities-related groundwater. Its texture is described as a loam. An examination of the analytical results (Tables 4.5-18 and 4.5-19) shows beryllium to be slightly above (1.4 mg/kg)

representative subsurface soil levels (1.2 mg/kg). Arsenic values were below the representative level for subsurface soils. The EMF characteristic constituents are totally absent. As was true with SD11, this very quiet pond is also within the influence of potential air deposition of EMF facilities-related constituents, as is shown by offsite soil sample 000-2A (Table 4.3-1). And, as was true at SD11, there was no measurable evidence of an EMF facilities-related impact in the sediment. This observation provides further evidence, as will SD07 below, that neither air deposition nor overland runoff is a pathway for sediment impact.

Sampling stations SD07 and SD05 are located in the Papoose Spring System. Sediment sampled at location SD07 was taken in the northeastern portion of the pond fed by Papoose Spring. Its texture was clayey, sandy gravel. Sediment sample SD5 was taken at the mouth of the spring reach as it enters the Portneuf River. Its texture was silty clay. There is an operational fish farm between these two points and the pond, and the creek formed by it is part of the operation. The only parameter with an above-representative concentration in the pond sediment was arsenic (9.1 mg/kg). The other parameters were generally well below the representative soil mean. Analytical results for the sample collected at station SD05 indicate above-representative soil levels of lead (50.5 mg/kg) and zinc (54.3 mg/kg). Because there were no EMF characteristic constituents, the enrichment of these elements should be attributed to other unknown sources.

SD04 sediment was taken at a spring near Siphon Road (Figure 2.5-1). Its texture was loam. While there were no above-representative soil parameters in this sample, both arsenic (8.2 mg/kg) and chromium (20.6 mg/kg) are close to the upper end of the representative soil range (8.5 mg/kg and 26.9 mg/kg, respectively). While arsenic was found in EMF-facilities-impacted groundwater, chromium was not. The remaining parameters detected in this sample were well below the means of representative soil constituents. Since no other EMF facilities-related parameters showed enrichment at this sampling station, it can be concluded that the enriched arsenic and chromium are due to other causes.

SD2 sediment was taken on the eastern branch of Twenty Spring (Figure 2.5-1). It was silty clay. The area in which it was taken was very swampy. In addition, the recovery for the sample was poor insofar as it was reported to consist of only 20 percent solids. Samples with this low of a percent solids content are very difficult to properly quantitate on a dry weight basis. The results from such quantitation are generally biased high. Hence, while elements reported as detected in the sample were probably present, their reported value will be biased high. Keeping this in mind, four constituents were found in concentrations above representative soil levels (Tables 4.5-18 and 4.5-19). These constituents were arsenic (13.8 mg/kg), beryllium (2.2 mg/kg), chromium (54 mg/kg), and vanadium (192 mg/kg). Zinc,

which is generally found in much greater quantities than vanadium in EMF potential source-related matrices, was below the representative soil mean at 37.4 mg/kg, and fluoride and total phosphorus were close to depleted at 75.3 mg/kg (561 mg/kg is representative) and 64.5 mg/kg (841 mg/kg is representative), respectively. While the four above representative parameters can be found in EMF potential source-related matrices, the detected levels of other parameters that have strong association with EMF matrices would indicate that this sample had not been affected by EMF facilities-related activities.

4.5.3.5 Radioactive Parameters in Spring Sediment Samples

Spring sediments, in general, had higher levels of gross alpha than the river sediments (Table 4.5-20). There was no apparent geographic correlation with high versus low. For example, the highest value (19.8 ± 2.49 pCi/g) was found at SD14 (Batiste Spring), which is fed by Bannock Range water that is impacted by the EMF industrial activities. However, a similar value (14.8 ± 1.35 pCi/g) was found at SD13, located on the east side of the river and fed by the Portneuf River Valley hydrogeochemical regime which is uninfluenced by the EMF facilities. The only readily available explanation would appear to lie in the sediment depositional theory developed above. That is to say, within the EMF study area, there is very little overland runoff contribution to the river. In addition, the river, because of the texture of the soils and the presence of dense vegetation, has little erosional potential at the present time. This observation would mean that sediments found within the main channel of the river (with the possible exception of industrial and commercial discharges) were derived from areas further upstream. On the other hand, the sediments found in the springs and their reaches (which are tributary to the river) are locally derived and have somewhat higher gross alpha activity than the upstream sources. Gross alpha activity developed for representative soils would tend to support this conclusion; the average value is 24.7 pCi/g.

With reference to river sediments, the same pattern exists for gross beta as exists for gross alpha. However, since the sample at SD14 was taken in sand and gravel, it does not have the highest gross beta activity. Rather, the highest gross beta activity was found in the more clay-rich sediments (SD2, SD5, and SD9). Average gross beta activities for representative soils were found to be 31.4 pCi/g.

4.5.3.6 Nature and Extent of Site-Related Parameters in Surface Water Sediments

The only sediment sample that directly reflects a release from the EMF facilities was the one collected at the current FMC outfall (SD17). The investigation in the area of the outfall demonstrated a very local influence from this outfall (i.e., impacted

sediments were not encountered further downstream). Since the two sampling events (Phase I and Phase II) occurred approximately 12 months apart, the presence or absence of the impacted sediments did not appear to be affected by spring thaw river water levels or flow rate. This implies that the sediments are not moving appreciably. Figures 4.5-20 and 4.5-22 show the concentrations of the indicator metals found at each spring and river station sampling point. As can be seen from these figures, only the sample from location SD17 had above-representative averages for all four metals. For the most part, the sediments sampled (with the exception of some zinc excursions) were all at or below representative levels. Figures 4.5-21 and 4.5-23 are bar charts of total phosphorus and fluoride concentrations obtained in the sediment samples. At location SD17, both elements were considerably above-representative levels. The remaining sample locations had excursions for one or the other element, but not both, and in general were below the representative soil range.

Arsenic values were at or near representative levels for all river sediment samples, except those taken at station SD18 (8.4 mg/kg) and station SD08 (9.9 mg/kg). The sediments of neither of these stations had the suite of metals, fluoride, and total phosphorus associated with the EMF facilities. While several of the spring sediments had arsenic levels above the river/spring mean, only two had above-representative values. These were SD7 at Papoose Spring (9.1 mg/kg) and SD2 at Twenty Spring-East (13.8 mg/kg). The Papoose Spring sample was taken in a ponded water area with very low energy, and the sample from Twenty Springs was taken in a low-energy swampy area. Like the river sediments, neither of these stations had the suite of metals, fluoride, and total phosphorus associated with the EMF facilities.

As can be seen in Figure 4.5-26, the highest levels of lead were detected in upstream sampling locations SD23 and SD24 (71.9 mg/kg and 51.6 mg/kg) respectively. While they may be related to nearby industrial activity, they are not related to EMF facilities operations. The next highest lead concentrations in the river were found at locations SD19 and SD20. In general, lead concentrations were higher in upstream samples than in downstream samples. Figure 4.5-27 displays the lead values detected in the spring sediments. The discharge point of the Papoose System had the highest level of lead detected in spring sediment (50.5 mg/kg). Since this level was not observed at the head of the spring (7.6 mg/kg), some activity, such as the fish farm operations, that lie between it and the discharge point could have contributed to the observed elevated lead concentrations.

Trace metal concentrations were consistently high (but not necessarily above the representative soil level) at location SDB1. Some of the enriched metals found at this location are also found in EMF facilities-related particulates. However, the

absence of cadmium and, more importantly, the absence of fluoride and total phosphorus in these samples at enriched levels would preclude their being associated with EMF facilities-related particulate. Because this location is the site of a recreational boat launching area, anthropogenic activities other than those occurring at the EMF facilities are probably responsible for the increased metals values.

Mercury at detectable levels was found in one upstream location (SDA1) and one downstream location (SDB1) (the previously mentioned boat launching site). The highest concentration detected was at SDB1 (1.1 mg/kg) with the level at SDA1 being 0.55 mg/kg. Mercury was found in representative soils at levels up to 0.3 mg/kg. The distribution does not appear to be related to any identified specific source along the river or spring reaches.

Cadmium was only detected in river sediments above the representative soil level at the FMC outfall (22.2 mg/kg). Spring sediment sampling station SD13 (near the STP sludge drying ponds) was the only spring sampling station to have an above-representative (for subsurface soils) cadmium value (1.5 mg/kg).

The highest total phosphorus value detected in the river sediments was at station SD10 (7,150 mg/kg). This station is on the river where it is joined by the Batiste Spring drainage. The concentration of total phosphorus at Batiste Spring was 286 mg/kg. An examination of river geometry indicates that this is probably a deposition point for STP effluents, which are high in phosphates. The next highest value of total phosphorus was found at the FMC outfall (5,340 mg/kg), with some enrichment also being observed in the Portneuf Bottoms area (C1, 1,160 mg/kg; C4, 1,060 mg/kg), which reflect discharge from the local fish farm.

Gross alpha activities appear to be directly related to soil textures, with sediments rich in clay or gravel being generally higher than those containing silt or sand. Spatial location does not appear to be a factor. The one exception was at the FMC outfall, which had the highest level of gross alpha activity (29.2 ± 3.6 pCi/g).

With some exceptions, gross beta activities were correlated well to Potassium-40 content. As for gross alpha activities, the FMC outfall area was the exception to this generalization and contained the highest gross beta value (30.0 ± 3.2 pCi/g).

These observations lead to the following conclusions:

- Precipitation of constituents of interest from groundwater does not appear to be occurring in a measurable fashion.

Section 4 Nature and Extent of Constituents of Potential Concern

- Deposition of particulate or gaseous compounds into the surface waters with a resultant enrichment of sediment is not occurring at a measurable rate.
- Overland transport of impacted soils by precipitation events does not appear to occur in the study area.
- The only EMF facilities-related impact on Portneuf River sediments was at the FMC outfall, where constituents associated with precipitator dust and phosphate ore were encountered.
- The only observed impact on Portneuf River sediments in the Fort Hall Bottoms area, as indicated by the three samples taken in that reach of the Portneuf River, that can be attributed to anthropogenic activities appear to be enriched levels of phosphates. Since these are not associated with other EMF potential source characteristic constituents, they are probably derived from sources other than the EMF facilities such as the fish farms and STP.

Section 4.6

4.6 REFERENCES

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Tables for Section 4.4

Table 4.4-1
Common Ions and Physical Parameters in Representative EMF Groundwater

| Parameter | REPRESENTATIVE CONCENTRATIONS | | CALCIUM-CHLORIDE WATER CHEMISTRY | | | | | | CALCIUM-BICARBONATE WATER CHEMISTRY | | | | | | | | | | | | | | | | | | | |
|---|-------------------------------|--------------|---------------------------------------|---------|----------|-----------|----------------|-------------------------|---------------------------------------|----------|----------------|------------|----------|---------|----------|-----------|----------------|-------|--|----------|------------|----------|---------|---------|---------|----------------|------|------------|
| | | | Michaud Flats Hydrogeochemical Regime | | | | | | Bannock Range Hydrogeochemical Regime | | | | | | | | | | Portneut River Hydrogeochemical Regime | | | | | | | | | |
| | High-chloride Subgroup | | | | | | | | Low-chloride chloride Subgroup | | | | | | | | | | | | | | | | | | | |
| | 16 Wells | Well 101 | Well 102 | TW-105 | Well 147 | Group | | Well 130 | Well 120 | Subgroup | Idaho Power | Well 106 | Well 301 | PEI-1 | Well 305 | Subgroup | Group | PEI-6 | Well 510 | Well 511 | Well 512 | Well 513 | Group | | | | | |
| Mean | Range (2 S.D.)(a) | Mean | Mean | Mean | Mean | Mean | Range (2 S.D.) | Mean | Mean | Mean | Range (2 S.D.) | Mean | Mean | Mean | Mean | Mean | Range (2 S.D.) | Mean | Range (2 S.D.) | Mean | Mean | Mean | Mean | Mean | Mean | Range (2 S.D.) | | |
| COMMON IONS (in mg/l) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Alkalinity, bicarbonate | 195 | 75 to 315 | 145 | 148 | 156 | 194 | 158 | 122 to 187 | 209 | 216 | 212 | 184 to 241 | 165 | 150 | 138 | 182 | 134 | 157 | 118 to 196 | 181 | 115 to 246 | 324 | 281 | 285 | 273 | 281 | 298 | 226 to 370 |
| Alkalinity, carbonate | 1.2 | ND to 8 | 2.5 | 2.5 | 1.7 | 0.0 | 1.9 | ND to 7 | 2.5 | 1.7 | 2.0 | ND to 7 | NH | 2.5 | 0.0 | 0.0 | 0.0 | 0.8 | ND to 5 | 1.4 | ND to 6 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.1 | ND to 1 |
| Calcium | 72.6 | 40 to 105 | 85.5 | 77.7 | 85.7 | 100 | 85.0 | 66 to 104 | 80.4 | 68.0 | 74.2 | 52 to 97 | 45.7 | 59.5 | 42.6 | 58.7 | 48.6 | 53.7 | 35 to 73 | 62.4 | 33 to 91 | 79.0 | 79.7 | 81.9 | 66.1 | 64.1 | 75.4 | 50 to 101 |
| Chloride | 87.2 | ND to 177 | 139 | 112 | 167 | 165 | 142 | 89 to 196 | 90.6 | 81.7 | 86.1 | 71 to 101 | 45.9 | 47.2 | 43.0 | 39.3 | 46.9 | 44.6 | 35 to 84 | 62.7 | 19 to 106 | 62.0 | 60.8 | 59.1 | 40.9 | 26.6 | 52.9 | 23 to 82 |
| Magnesium | 26.5 | 11 to 42 | 31.6 | 27.9 | 27.9 | 30.2 | 29.3 | 24 to 34 | 32.8 | 27.5 | 30.1 | 23 to 37 | 17.1 | 20.9 | 11.1 | 15.4 | 11.6 | 16.8 | ND to 35 | 22.5 | 3 to 42 | 32.5 | 31.0 | 30.2 | 27.8 | 31.2 | 31.0 | 23 to 39 |
| Potassium | 8.3 | 4 to 13 | 8.5 | 8.0 | 10.3 | 11.6 | 9.3 | 5 to 18 | 10.3 | 8.8 | 9.5 | 6 to 13 | 8.1 | 9.7 | 5.9 | 6.2 | 5.5 | 7.7 | 4 to 12 | 8.5 | 4 to 13 | 6.5 | 6.3 | 6.2 | 6.5 | 6.8 | 6.5 | 5 to 8 |
| Sodium | 33.2 | 7 to 64 | 32.0 | 29.3 | 57.2 | 64.6 | 42.5 | 11 to 74 | 26.9 | 46.5 | 36.7 | 18 to 88 | 24.7 | 22.8 | 22.5 | 14.0 | 16.9 | 20.4 | 10 to 31 | 27.5 | 8 to 50 | 39.7 | 40.0 | 36.2 | 52.1 | 35.9 | 40.5 | 25 to 86 |
| Sulfate | 46 | 14 to 79 | 65 | 49 | 36 | 66 | 82 | 26 to 78 | 62 | 50 | 86 | 39 to 73 | 24 | 36 | 12 | 16 | 32 | 26 | 6 to 47 | 39 | 4 to 74 | 53 | 53 | 48 | 50 | 72 | 58 | 38 to 74 |
| PHYSICAL PARAMETERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Specific conductance, at 25°C (in $\mu\text{mhos/cm}$) | 720 | 387 to 1052 | 832.8 | 750.3 | 881.8 | 975.5 | 840 | 621 to 1059 | 781.0 | 745.8 | 763 | 686 to 841 | 592.4 | 521.1 | 442.3 | 409.8 | 486.0 | 497 | 286 to 708 | 610 | 296 to 924 | 769.8 | 799.3 | 825.0 | 729.3 | 740.0 | 772 | 611 to 933 |
| pH(b) | | 6.9 to 9.4 | 7.5 | 7.6 | 7.5 | 7.4 | | 7.2 to 8.5 | 7.4 | 7.2 | | 7.0 to 7.9 | 7.6 | 7.6 | 7.2 | 8.0 | 7.4 | | 6.9 to 9.4 | | 6.9 to 9.4 | 7.7 | 7.2 | 7.2 | 7.3 | 7.3 | | 7.1 to 8.9 |
| | | | 8.5 max | 8.5 max | 7.8 max | 7.5 max | | | 7.9 max | 7.4 max | | | 7.9 max | 7.7 max | 7.4 max | 9.4 max | 7.4 max | | | | | 8.9 max | 7.8 max | 7.2 max | 7.3 max | 7.3 max | | |
| | | | 5.8 min | 7.4 min | 7.2 min | 7.2 min | | | 7.3 min | 7.0 min | | | 7.3 min | 7.4 min | 6.9 min | 7.4 min | 7.3 min | | | | | 7.1 min | 7.1 min | 7.1 min | 7.2 min | 7.3 min | | |
| Temperature (in C°) | 14.7 | 11.4 to 17.9 | 13.4 | 13.9 | 14.3 | 16.7 | 14.2 | 11 to 17 | 14.5 | 15.6 | 15.0 | 13 to 17 | 15.4 | 16.8 | 14.5 | 16.5 | 16.3 | 16.1 | 13 to 19 | 15.6 | 13 to 18 | 13.7 | 13.1 | 13.2 | 13.1 | 12.6 | 13.2 | 12 to 19 |
| Total dissolved solids (in mg/l) | 461 | 175 to 746 | 512 | 479 | 544 | 773 (594) | 842 (516) | 209 to 876 (990 to 641) | 501 | 475 | 488 | 362 to 614 | 322 | 333 | 303 | 324 (795) | 357 | 315 | 163 to 468 | 389 | 166 to 611 | 534 | 497 | 487 | 443 | 447 | 493 | 394 to 991 |
| Redox (mV) (c) | | | 156 | 141 | -38 | 42 | | | 255 | 69 | | | 41 | 104 | 61 | NM | 65 | | | | | 104 | 131 | 137 | 76 | 83 | | |

(a) S.D. = Standard Deviation. Range is mean \pm two times Standard Deviation.

(b) Range is actual values rather than two times Standard Deviation.

(c) Single Measurement.

ND = Below Detection Limit, NH = Not Detected in any sample, NM = Not Measured.

Table 4.4-2
Nutrients and Related Parameters in Representative EMF Groundwater

| Parameter | Sample Detection Limit (Mean) | REPRESENTATIVE CONCENTRATIONS (16 WELLS) | | CALCIUM-CHLORIDE WATER CHEMISTRY | | | | | | CALCIUM-BICARBONATE WATER CHEMISTRY | | | | | | | | | | | | | Portneuf River Hydrogeochemical Regime | | | | | | |
|--|--|--|-----------|---------------------------------------|--------------------|----------|----------------|------------|---------------|---|-----------------|------------|------------|------|-----------------|---------------------------|----------|----------|-----------------------|------------|------------|-----------------|--|-----------------|------|------|------|------------|------------|
| | | | | Michaud Flats Hydrogeochemical Regime | | | | | | Bannock Range Hydrogeochemical Regime | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | Well 101 Well 102 TW-103 Well 147 Group | | | | | | High-Chloride Subgroup | | | Low-Chloride Subgroup | | | | | | | | | | |
| | | | | Well 130 | Well 120 | Subgroup | Idaho Power | Well 106 | Well 301 | | | | | | | PEI-1 | Well 305 | Subgroup | Group | | | | | | | | | | |
| | | | | Mean | Range (2 SD)(a) | Mean | Mean | Mean | Mean | Mean | Range (2 SD) | Mean | Mean | Mean | Range (2 SD) | Mean | Mean | Mean | Mean | Mean | Mean | Range (2 SD) | Mean | Range (2 SD) | Mean | Mean | Mean | Mean | Mean |
| (In mg/l) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ammonia (NH ₃ as N) | 0.3 | 0.2 | ND to 0.8 | NH | 0.8 | NH | NH | 0.8 | ND to 0.8 | 0.3 | NH | 0.3 | ND to 0.3 | NH | NH | NH | 0.1 | NH | 0.1 | ND to 0.2 | 0.1 | ND to 0.3 | 0.2 | NH | NH | NH | NH | 0.2 | ND to 0.9 |
| Nitrate (NO ₃ as N) | 2.1 | ND to 4.5 | 1.7 | 1.8 | 4.8 | 2.5 | 2.8 | ND to 5.7 | 1.9 (48.3) | 1.6 | 1.8 | 0.8 to 2.7 | 1.3 | 1.0 | 0.8 | 0.8 | 0.9 | 1.0 | 0.3 to 1.7 | 1.3 | 0.2 to 2.4 | 1.8 | 3.3 | 2.3 | 3.6 | 3.3 | 2.6 | 0.9 to 4.3 | |
| Orthophosphate (PO ₄ as P) (RI data only) | 0.03 | 0.37 | ND to 1.8 | 0.06 | 0.06 | 0.06 | NH | 0.06 | ND to 0.14 | 0.61 | 2.50 | 1.56 | ND to 3.68 | 0.03 | 0.05 | 0.04 | 0.21 | 0.06 | 0.09 | ND to 0.33 | 0.59 | ND to 2.5 | 0.24 | 0.03 | 0.03 | 0.04 | 0.03 | 0.11 | ND to 0.39 |
| | | | | 0.03 | 0.03 | 0.07 | NH | | | 0.62 | 2.72 | | | 0.03 | 0.04 | 0.04 | 0.18 | 0.06 | | | | 0.13 | 0.03 | 0.03 | 0.04 | 0.03 | | | |
| Phosphorus, Total (RI data only) | 0.03 | 0.67 | ND to 3.1 | 0.43 | 0.44 | 0.07 | 0.03 | 0.32 | ND to 1.9 | 0.78 | 3.26 | 2.02 | ND to 4.94 | 0.06 | 0.14 | 0.04 | 0.05 | 0.02 | 0.09 | ND to 0.31 | 1.1 | ND to 4.0 | 0.09 | 0.04 | 0.04 | 0.04 | 0.05 | 0.06 | ND to 0.13 |
| | | | | 0.03 | 0.04 | NH | 0.03 | | | 0.68 | 3.23 | | | 0.03 | 0.04 | 0.04 | 0.05 | 0.02 | | | | 0.09 | 0.04 | 0.04 | 0.04 | 0.05 | | | |
| Fluoride | 0.4 | 0.03 to 0.7 | 0.4 | 0.4 | 0.5 | 0.8 | 0.5 | 0.2 to 0.7 | | 0.3 | 0.2 | 0.2 | 0.1 to 0.3 | 0.4 | 0.5 | 0.7 | 0.4 | 0.5 | 0.5 | 0.1 to 0.8 | 0.4 | 0.003 to 0.7 | 0.2 | 0.2 | 0.2 | 0.2 | 0.4 | 0.2 | 0.1 to 0.4 |

(a) SD = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

ND = Below detection limit.

NH = Not detected in any sample ("No hits").

NM = Not measured.

NA = Not available.

Table 4.4-3
Metals in Representative EMF Groundwater

| Parameter | Sample Detection Limit (Mean) | REPRESENTATIVE CONCENTRATIONS (16 WELLS) | CALCIUM-CHLORIDE WATER CHEMISTRY | | | | | | | CALCIUM-BICARBONATE WATER CHEMISTRY | | | | | | | | | | | | | | | | | |
|------------|--|--|---|--|--|-------------|-----------------|-------------|-------------|---------------------------------------|-----------------|-------------|-------------|-------|-------------|----------|-------|-----------------|-------------|-----------------|-------------|-------------|-------|------|------|------|-----------------|
| | | | Michaud Flats Hydrogeochemical Regime | | | | | | | Barnock Range Hydrogeochemical Regime | | | | | | | | | | | | | | | | | |
| | | | High-Chloride Subgroup | | | | | | | Low-Chloride Subgroup | | | | | | | | | | | | | | | | | |
| | | | Portneuf River Hydrogeochemical Regime | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Well 101 | Well 102 | TW-103 | Well 147 | Group | Well 130 | Well 120 | Subgroup | Idaho Power | Well 100 | Well 301 | PEI-1 | Well 305 | Subgroup | Group | PEI-6 | Well S10 | Well S11 | Well S12 | Well S13 | Group | | | | |
| Mean | Range (2 SD) | Mean | Mean | Mean | Mean | Mean | Range (2 SD) | Mean | Mean | Mean | Range (2 SD) | Mean | Mean | Mean | Mean | Mean | Mean | Range (2 SD) | Mean | Range (2 SD) | Mean | Mean | Mean | Mean | Mean | Mean | Range (2 SD) |
| Aluminum | 0.05 0.05 | 0.18 ND to 0.68 | NH NH NH NH ND ND to ND | 0.02 NH 0.02 ND to 0.02 NH 0.50 0.07 0.14 NH 0.16 ND to 0.34 0.15 ND to 0.32 | 0.28 0.06 0.02 NH NH 0.22 ND to 0.9 | | | | | | | | | | | | | | | | | | | | | | |
| Antimony | 0.03 0.06 | 0.12 0.04 to 0.20 | NH NH NH NH ND ND to ND | NH NH ND ND to ND NH NH NH 0.10 0.17 0.14 0.04 to 0.23 0.14 0.04 to 0.23 | 0.10 NH NH NH NH 0.10 ND to 0.10 | | | | | | | | | | | | | | | | | | | | | | |
| Arsenic | 0.001 0.011 | 0.013 ND to 0.032 | 0.013 0.013 0.004 0.005 0.018 0.002 to 0.019 | 0.032 0.020 0.027 0.015 to 0.039 0.015 0.004 0.010 0.005 0.018 0.008 ND to 0.021 0.017 ND to 0.039 | 0.004 0.007 0.007 0.005 0.004 0.001 to 0.009 | | | | | | | | | | | | | | | | | | | | | | |
| Barium | 0.002 0.14 | 0.12 0.02 to 0.22 | 0.15 0.10 0.18 0.23 0.16 0.07 to 0.24 | 0.07 0.09 0.08 0.06 to 0.10 0.04 0.12 0.06 0.07 0.06 0.09 0.02 to 0.16 0.08 0.03 to 0.14 | 0.14 0.16 0.13 0.14 0.08 0.13 0.07 to 0.19 | | | | | | | | | | | | | | | | | | | | | | |
| Beryllium | 0.003 0.001 | 0.002 0.0007 to 0.003 | NH NH NH NH ND ND to ND | NH NH ND ND to ND NH NH 0.002 0.002 NH 0.002 0.002 to 0.002 0.002 0.002 to 0.002 | 0.002 NH NH 0.003 0.001 0.002 0.0004 to 0.004 | | | | | | | | | | | | | | | | | | | | | | |
| Boron | NA 0.17 | 0.17 ND to 0.36 | 0.11 0.09 0.12 0.13 0.11 0.04 to 0.19 | 0.21 0.22 0.22 0.03 to 0.40 0.11 0.06 0.04 0.26 0.09 0.14 ND to 0.39 0.17 ND to 0.40 | 0.22 0.16 0.17 0.17 0.16 0.19 ND to 0.37 | | | | | | | | | | | | | | | | | | | | | | |
| Cadmium | 0.010 0.004 | 0.003 0.001 to 0.006 | 0.004 0.004 0.004 NH 0.004 0.003 to 0.005 | 0.004 0.004 0.004 0.003 to 0.005 0.003 0.003 0.0001 0.0001 NH 0.003 ND to 0.006 0.003 0.001 to 0.006 | 0.001 NH NH NH NH 0.0003 0.001 ND to 0.002 | | | | | | | | | | | | | | | | | | | | | | |
| Chromium | 0.001 0.006 | 0.005 ND to 0.012 | 0.006 0.007 0.006 0.007 0.006 0.001 to 0.012 | 0.006 0.005 0.006 0.002 to 0.009 0.003 0.005 0.002 0.001 0.002 0.003 ND to 0.008 0.004 ND to 0.009 | 0.008 0.003 0.001 0.002 0.001 0.004 ND to 0.018 | | | | | | | | | | | | | | | | | | | | | | |
| Cobalt | 0.007 0.009 | 0.018 0.002 to 0.033 | 0.015 NH NH NH 0.018 0.018 to 0.018 | 0.027 NH 0.027 0.025 to 0.030 NH NH NH 0.010 NH 0.010 ND to 0.010 0.023 0.006 to 0.040 | 0.010 0.017 NH 0.009 0.016 0.013 0.005 to 0.021 | | | | | | | | | | | | | | | | | | | | | | |
| Copper | 0.006 0.004 | 0.007 ND to 0.022 | 0.008 0.004 0.004 NH 0.008 ND to 0.016 | 0.006 0.008 0.007 ND to 0.022 0.004 0.006 NH 0.014 NH 0.008 ND to 0.027 0.007 ND to 0.024 | 0.014 NH NH NH NH 0.014 ND to 0.036 | | | | | | | | | | | | | | | | | | | | | | |
| Iron | 0.007 0.03 | 0.21 ND to 1.1 | 0.29 0.15 0.24 NH 0.22 ND to 1.3 | 0.12 0.19 0.18 ND to 0.80 0.74 0.16 0.06 0.10 NH 0.19 ND to 0.86 0.17 ND to 0.81 | 0.32 NH NH NH NH 0.32 ND to 1.2 | | | | | | | | | | | | | | | | | | | | | | |
| Lead | 0.001 0.001 | 0.002 ND to 0.006 | 0.001 0.001 0.002 NH 0.001 ND to 0.004 | 0.001 0.002 0.001 ND to 0.004 0.003 0.001 NH 0.007 NH 0.003 ND to 0.008 0.002 ND to 0.006 | 0.005 0.002 NH 0.002 0.001 0.003 ND to 0.008 | | | | | | | | | | | | | | | | | | | | | | |
| Lithium | 0.005 0.019 | 0.031 ND to 0.062 | NH NH 0.042 0.058 0.038 0.028 to 0.072 | 0.027 0.027 0.027 0.006 to 0.046 NH 0.012 NH 0.007 0.009 0.008 0.003 to 0.013 0.017 ND to 0.040 | 0.035 0.031 0.027 0.030 0.029 0.031 0.020 to 0.043 | | | | | | | | | | | | | | | | | | | | | | |
| Manganese | 0.002 0.004 | 0.015 ND to 0.078 | 0.013 0.016 0.010 NH 0.012 ND to 0.057 | 0.007 0.013 0.010 ND to 0.053 0.006 0.012 NH 0.007 0.016 0.011 ND to 0.047 0.011 ND to 0.030 | 0.174 NH NH NH NH 0.174 ND to ND | | | | | | | | | | | | | | | | | | | | | | |
| Mercury | 0.0002 0.0002 | 0.0006 ND to 0.0013 | 0.0012 NH NH NH NH 0.0012 ND to 0.0013 | NH NH ND ND to ND 0.0002 0.0009 0.0002 0.0004 NH 0.0004 ND to 0.0011 0.0004 ND to 0.0011 | 0.0009 0.0003 0.0001 NH NH 0.0005 ND to 0.0013 | | | | | | | | | | | | | | | | | | | | | | |
| Molybdenum | NA 0.02 | 0.03 ND to 0.07 | NH NH NH NH ND ND to ND | 0.02 0.02 0.02 0.02 to 0.02 NH NH NH 0.02 NH 0.02 ND to 0.02 0.02 0.02 to 0.02 | 0.02 NH 0.03 0.03 0.07 0.04 ND to 0.08 | | | | | | | | | | | | | | | | | | | | | | |
| Nickel | 0.015 0.01 | 0.01 0.01 to 0.01 | NH NH NH NH ND ND to ND | 0.00 NH ND ND to ND NH NH NH 0.01 NH 0.01 ND to 0.01 0.01 ND to 0.01 | NH NH NH NH NH ND ND to ND | | | | | | | | | | | | | | | | | | | | | | |
| Selenium | 0.002 0.004 | 0.003 ND to 0.007 | 0.003 0.003 0.003 0.003 0.003 0.0005 to 0.006 | 0.004 0.003 0.004 ND to 0.010 0.003 0.002 NH 0.004 0.001 0.002 0.002 to 0.005 0.003 ND to 0.008 | 0.002 0.005 0.004 0.003 0.002 0.003 0.001 to 0.008 | | | | | | | | | | | | | | | | | | | | | | |
| Silver | 0.007 0.003 | 0.004 0.002 to 0.006 | 0.004 0.004 0.004 0.002 0.004 0.001 to 0.006 | 0.004 0.004 0.004 0.002 to 0.006 0.004 0.004 NH 0.002 0.007 0.004 0.001 to 0.01 0.004 0.002 to 0.01 | 0.003 NH NH NH NH 0.003 ND to 0.003 | | | | | | | | | | | | | | | | | | | | | | |
| Thallium | 0.040 0.002 | 0.040 0.04 to 0.040 | NH NH NH NH ND ND to ND | NH NH ND ND to ND NH NH NH 0.040 NH 0.040 ND to 0.040 0.040 ND to 0.040 | 0.040 NH NH NH NH 0.040 ND to ND | | | | | | | | | | | | | | | | | | | | | | |
| Vanadium | 0.008 0.046 | 0.024 ND to 0.124 | 0.008 0.008 0.005 0.004 0.007 0.003 to 0.011 | 0.008 0.007 0.008 0.004 to 0.012 0.007 0.007 0.006 0.007 NH 0.026 ND to 0.103 0.017 ND to 0.073 | 0.165 0.015 NH NH 0.015 0.115 ND to 0.331 | | | | | | | | | | | | | | | | | | | | | | |
| Zinc | 0.002 0.017 | 0.089 ND to 0.397 | 0.014 0.009 0.008 NH 0.010 ND to 0.023 | 0.008 0.010 0.009 0.001 to 0.018 0.287 0.008 NH 0.269 NH 0.166 ND to 0.794 0.088 ND to 0.531 | 0.129 0.008 0.005 NH NH 0.088 ND to 0.269 | | | | | | | | | | | | | | | | | | | | | | |

Notes:

(a) 2 SD = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

ND = Below Detection Limit.

NH = Not detected in any sample.

NM = Not measured.

NA = Not available.

IDL = Instrument Detection Limit

Table 4.4-4
Activities for Radiological Parameters in Representative EMF Groundwater

| Radiological Parameter (pCi/l) | CALCIUM-CHLORIDE WATER CHEMISTRY | | | | CALCIUM-BICARBONATE WATER CHEMISTRY | | | | | | | | | | | |
|-----------------------------------|---------------------------------------|-------------|-----------|-------------|---------------------------------------|-------------|-----------------------|-------------|-------------|-----------|-------------|--|-------------|-------------|-------------|-------------|
| | Michaud Flats Hydrogeochemical Regime | | | | Bannock Range Hydrogeochemical Regime | | | | | | | Portneuf River Hydrogeochemical Regime | | | | |
| | | | | | High-Chloride Subgroup | | Low-Chloride Subgroup | | | | | | | | | |
| | Well 101 | Well 102 | TW-10S | Well 147 | Well 130 | Well 120 | Idaho Power | Well 106 | Well 301 | PEI-1 | Well 305 | PEI-6 | Well 510 | Well 511 | Well 512 | Well 513 |
| Gross alpha | | | | | | | | | | | | | | | | |
| Jun-92 | 2.6±1.9 | ND | 3.4±3 | ND | 3.7±2.4 | ND | ND | ND | RS | 2.4±1.3 | RS | 4.6±2.3 | RS | RS | RS | RS |
| Sep-92 | 4.4±2.45 | 2.28±1.87 | 3.45±0.36 | 2.66±0.4 | ND | ND | 2.65±0.58 | 4.59±1.95 | 4.57±0.89 | 2.78±0.41 | 3.08±0.45 | 3.39±0.35 | ND | ND | 2.21±0.64 | 2.07±0.73 |
| Dec-92 | 7.34±2.38 | 4.5±1.72 | 5.36±2.52 | 5.18±1.14 | 3.74±1.94 | ND | 3.31±0.99 | 3.76±0.96 | 2.66±0.55 | NS | 2.98±1.02 | 2.31±0.59 | ND | ND | ND | ND |
| Mar-93 | 2.94±1.6 | 3.94±1.24 | 5.82±2.07 | 4.39±1.05 | 3.14±1.08 | 3.5±3.89 | 4.78±1.48 | ND | 4.94±1.06 | NS | 3.93±1.37 | 3.56±1.48 | 2.88±0.853 | 2.24±0.932 | 2.59±1.33 | 3.48±1.44 |
| Gross beta | | | | | | | | | | | | | | | | |
| Jun-92 | 4.1±2.9 | 6.5±3 | 6.1±3.4 | 20.6±3.5 | 7.6±3.5 | 3.8±3.5 | 14±3.1 | ND | RS | 11±3.7 | RS | 9.1±2.9 | RS | RS | RS | RS |
| Sep-92 | 8.11±1.81 | 6.97±1.74 | 8.27±0.39 | 14.3±0.48 | 8.9±1.8 | 9.53±1.75 | 10.9±0.91 | 9.04±1.82 | 6.29±0.82 | 7.95±0.49 | 6.89±0.52 | 4.44±0.46 | 6.11±0.7 | ND | 7.64±0.73 | 9.3±0.88 |
| Dec-92 | 9.77±1.35 | 9.53±1.46 | 10.1±1.49 | 10.8±0.94 | 7.66±1.37 | 5.22±0.41 | 7.17±0.88 | 8.43±0.757 | 5.87±0.72 | NS | 5.57±0.95 | 4.04±0.56 | ND | ND | ND | ND |
| Mar-93 | 45.8±2.65 | 7.61±0.98 | 7.05±0.96 | 9.85±1.01 | 7.3±1.72 | 30±5.12 | ND | 7.18±1.15 | ND | NS | 6.67±1.23 | ND | 7.44±1.45 | 7.47±1.42 | ND | ND |
| Radium-226 | | | | | | | | | | | | | | | | |
| Jun-92 | NA | NA | NA | NA | NA | NA | NA | NA | RS | NH | RS | NA | RS | RS | RS | RS |
| Sep-92 | ND | ND | 6.35±0.57 | ND | ND | 1.55±0.42 | ND | ND | 1.65±0.53 | ND | ND | ND | ND | ND | ND | ND |
| Dec-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | NS | 3.41±0.29 | ND | ND | ND | ND | ND |
| Mar-93 | ND | ND | ND | 1.82±0.26 | ND | ND | ND | ND | ND | NS | ND | ND | ND | ND | ND | ND |
| Radium-228 | | | | | | | | | | | | | | | | |
| Jun-92 | ND | ND | ND | ND | ND | ND | ND | ND | RS | NH | RS | ND | RS | RS | RS | RS |
| Sep-92 | 1.2±0.8 | 1.8±0.9 | 4.2±1 | ND | ND | ND | 1.2±0.7 | 1±0.8 | 2.7±1 | ND | ND | ND | ND | ND | ND | 2.1±0.5 |
| Dec-92 | ND | 6.5±1.2 | ND | ND | ND | 1.3±0.7 | ND | ND | 1±0.6 | NS | 2±1 | ND | ND | ND | ND | ND |
| Mar-93 | ND | ND | ND | ND | ND | ND | ND | ND | 1±0.7 | NS | ND | 5.4±1 | ND | 7.2±1 | ND | ND |

Notes:
 NA - Not analyzed.
 ND - Not detected.
 NH - No hits.
 NS - Not sampled.
 RS - Rejected sample.

Section 4 Nature and Extent of Constituents of Potential Concern

Table 4.4-5
Organic Compounds Reported in Groundwater from Representative Wells

| Parameter | Sample Event | CALCIUM-CHLORIDE WATER CHEMISTRY Michaud Flats Hydrogeochemical Regime | | | CALCIUM-BICARBONATE WATER CHEMISTRY Bannock Range Hydrogeochemical Regime, Low-Chloride Subgroup | | | Portneuf River Hydrogeochemical Regime | | |
|---------------------------------|------------------|---|----------|--------|---|----------------|--------|---|----------|----------|
| | | Well 101 | Well 102 | TW-10S | Well 106 | Well 301 | PEI-1 | PEI-6 | Well 511 | Well 513 |
| 2-Butanone | Sep-92 Mar-93 | | | | | | 0.003J | | | 0.004J |
| Acetone | Sep-92 Dec-92 | | | | | 0.361J 0.12 | 0.524J | | 0.044 | 0.1J |
| Bis(2-ethylhexyl) -phthalate | Sep-92 | | | | | | | 0.001J | 0.017 | |
| | Dec-92 | 0.004J | 0.002J | 0.004J | 0.005J | 0.026 | | 0.013 | 0.013 | 0.003J |
| | Dec-92 | | | | | | | | | 0.001J |
| | Mar-93 | | | | | 0.054 | | 0.025 | 0.012 | |
| Carbon disulfide | Sep-92 | | | | | | | | 0.027J | 0.033J |
| Chlorobenzene | Sep-92 | 0.001J | | | | | | | | |
| Di-n-butyl phthalate | Mar-93 | | | | | 0.001J | | | 0.002 | |
| Ethyl benzene | Sep-92 | | | | | 0.001 | | | | |
| Methylene chloride | Sep-92 | | | | | | | | | |
| Tetrachloroethene | Sep-92 | | | | | | | | 0.003J | |
| | Dec-92 | | | | | | | | 0.001J | |
| | Mar-93 | | | | | | | | 0.003 | |
| Trichloroethene | Sep-92 | | | | | | | 0.005 | | |
| Xylenes, total | Sep-92 | | | | | 0.008 | 0.006 | | | |
| | Mar-93 | | | 0.001J | | | | | | |

J = Validation qualifier indicating estimated quantity.

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Site Characterization Summary

Table 4.4-6
Ranges of Common Ion Concentrations, Physical Parameters,
Nutrient, and Fluoride Concentrations for All EMF Monitoring Wells

| PARAMETER | UNIMPACTED WELLS | | | | | | | | | | | | | | | IMPACTED WELLS | | | | | | | | | REPRESENTATIVE CONCENTRATIONS (2 S.D.) (a) | | | | | | | | | | | |
|---------------------------------|---------------------|--------------|------|--------------|--------------|------|----------------------|--------------|------|----------------------|--------------|------|-----------------------|--------------|------|---------------------|--------------|------|----------------------|--------------|------|-----------------------|--------------|------|--|---------------|------|--------------|--------------|------|--------------|--------------|------|---------------|--|--|
| | EMC Wells | | | | | | Simplex Wells | | | | | | Offsite Wells | | | | | | EMC Wells | | | Simplex Wells | | | | Offsite Wells | | | | | | | | | | |
| | Michael Dean Region | | | Well 13a | | | Barnock Range Region | | | Barnock Range Region | | | Portonut River Region | | | Michael Dean Region | | | Barnock Range Region | | | Portonut River Region | | | | | | | | | | | | | | |
| | Mean | Min. | Max. | Mean | Min. | Max. | Mean | Min. | Max. | Mean | Min. | Max. | Mean | Min. | Max. | Mean | Min. | Max. | Mean | Min. | Max. | Mean | Min. | Max. | | Mean | Min. | Max. | Mean | Min. | Max. | Mean | Min. | Max. | | |
| COMMON IONS (mg/l) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Alkalinity, bicarbonate | 181 | 136 to 253 | | 191 | 175 to 204 | | 188 | 142 to 256 | | 159 | 132 to 218 | | 284 | 256 to 308 | | 205 | 162 to 300 | | 176 | 126 to 266 | | 280 | 241 to 304 | | 559 | 196 to 1560 | | 830 | 1 to 1860 | | 284 | 189 to 355 | | 315 | | |
| Calcium | 95 | 62.2 to 156 | | 377 | 332 to 432 | | 61.2 | 41.4 to 89.6 | | 51.4 | 34.1 to 77 | | 72.1 | 47.0 to 91.7 | | 86.2 | 45.8 to 120 | | 49.4 | 15.4 to 77 | | 76.1 | 44.0 to 99.1 | | 146 | 29.8 to 531 | | 378 | 70.4 to 795 | | 98.9 | 52.7 to 163 | | 105 | | |
| Chloride | 167 | 108 to 284 | | 1062 | 853 to 1660 | | 74.3 | 11.2 to 244 | | 42.4 | 24.0 to 60 | | 62 | 52.6 to 72.1 | | 167 | 103 to 276 | | 34.3 | 16.0 to 104 | | 50.5 | 20.0 to 70.7 | | 220 | 50 to 644 | | 122 | 41.0 to 206 | | 118.7 | 34.9 to 274 | | 177 | | |
| Magnesium | 31.3 | 23.2 to 49 | | 140 | 130 to 155 | | 22 | 12.9 to 59.3 | | 13.7 | 9.5 to 22.1 | | 30.4 | 26.9 to 34.5 | | 31.5 | 20.8 to 45.3 | | 17 | 10.3 to 32.0 | | 30.2 | 23.8 to 35.6 | | 74.4 | 10.6 to 330 | | 173 | 19.9 to 694 | | 40.4 | 19.9 to 65.0 | | 42 | | |
| Potassium | 11.4 | 4.9 to 31.0 | | 35.3 | 30.7 to 38.9 | | 9.2 | 4.6 to 20.2 | | 5.6 | 3.5 to 6.8 | | 6.1 | 4.7 to 6.7 | | 9 | 4.7 to 13.6 | | 5.1 | 2.9 to 8.8 | | 6.4 | 4.3 to 7.4 | | 168 | 5.5 to 1400 | | 68.2 | 26.8 to 258 | | 44.6 | 6.4 to 138 | | 13 | | |
| Sodium | 73.1 | 27.4 to 187 | | 245 | 211 to 271 | | 46.7 | 22.5 to 92.7 | | 26.4 | 12.6 to 48.6 | | 34.1 | 20.9 to 44.7 | | 82.3 | 33.7 to 154 | | 33.3 | 15.4 to 81 | | 41.4 | 30.9 to 53.5 | | 253 | 25 to 1110 | | 359 | 31.1 to 752 | | 92 | 34.9 to 175 | | 64 | | |
| Sulfate | 84 | 36 to 159 | | 570 | 551 to 579 | | 53 | 0.8 to 91 | | 41 | 8.0 to 109 | | 50 | 41 to 65 | | 111 | 70 to 186 | | 45 | 15 to 95 | | 55 | 41 to 90 | | 371 | 81 to 1840 | | 1613 | 101 to 3510 | | 183 | 61 to 574 | | 79 | | |
| PHYSICAL PARAMETERS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| pH | 6.98 to 7.64 | | | 6.82 to 7.02 | | | 6.93 to 8.99 | | | 6.91 to 9.40 | | | 7.03 to 9.40 | | | 7.09 to 9.00 | | | 7.10 to 10.11 | | | 7.04 to 9.30 | | | 5.95 to 7.80 | | | 1.61 to 7.70 | | | 6.32 to 7.33 | | | 6.9 to 9.4(b) | | |
| Specific conductance (umhos/cm) | 1056 | 731 to 1601 | | 4047 | 3861 to 4247 | | 697 | 413 to 982 | | 519 | 402 to 760 | | 829 | 700 to 1037 | | 1176 | 639 to 1759 | | 581 | 403 to 1110 | | 776 | 593 to 855 | | 2443 | 819 to 6656 | | 4008 | 752 to 11147 | | 1256 | 596 to 1956 | | 1052 | | |
| Temperature (°C) | 14.4 | 12.1 to 16.8 | | 13.5 | 13.2 to 13.7 | | 15.8 | 12.3 to 19.7 | | 15.6 | 13.3 to 17.1 | | 13.7 | 12.4 to 16.9 | | 12.1 | 8.0 to 15.3 | | 14 | 10.5 to 22.8 | | 13.6 | 12.1 to 17.6 | | 16.1 | 10.5 to 30.0 | | 17.1 | 13.3 to 19.8 | | 14.4 | 10.0 to 18.1 | | 11.4 to 17.9 | | |
| TDS (mg/l) | 643 | 350 to 1420 | | 2873 | 2700 to 3170 | | 438 | 190 to 840 | | 358 | 260 to 480 | | 507 | 390 to 600 | | 700 | -70 to 1120 | | 325 | 160 to 570 | | 485 | 420 to 580 | | 1775 | 500 to 5220 | | 3743 | 450 to 14400 | | 850 | 370 to 1340 | | 746 | | |
| Redox (mV) | 131 | -38 to 243 | | 294 | 294 to 294 | | 92 | -107 to 255 | | 87 | 61 to 130 | | 92 | 74 to 104 | | 70 | 56 to 83 | | 59 | -28 to 122 | | 120 | 76 to 154 | | 64 | -306 to 442 | | 117 | 80 to 307 | | 37 | -117 to 137 | | | | |
| NUTRIENTS & FLUORIDE (mg/l) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ammonia (NH3 as N) | 0.8 | 0.8 to 0.8 | | ND | ND to 0.0 | | 0.6 | 0.3 to 0.9 | | 0.5 | 0.5 to 0.5 | | 0.5 | 0.5 to 0.5 | | 0.5 | 0.4 to 0.5 | | 0.5 | 0.5 to 0.5 | | 0.5 | 0.4 to 0.5 | | 4.7 | 0.3 to 13 | | 6.7 | 0.2 to 70 | | 5.6 | 0.20 to 72 | | 0.8 | | |
| Nitrate (NO3 as N) | 2.9 | 1.3 to 6.3 | | 34.9 | 29.5 to 43.5 | | 1.2 | 0.4 to 2.6 | | 0.8 | 0.6 to 1.1 | | 2.1 | 1.5 to 3.1 | | 3.3 | 1.6 to 7.7 | | 1.4 | 0.5 to 4.6 | | 2.9 | 1.7 to 4.6 | | 7.9 | 0.1 to 32 | | 12 | 0.1 to 82 | | 7.1 | 1.5 to 33 | | 4.5 | | |
| Orthophosphate (PO4 as P) | 0.16 | 0.02 to 0.39 | | 0.1 | 0.08 to 0.1 | | 0.82 | 0.02 to 3.1 | | 0.06 | 0.02 to 0.24 | | 0.06 | 0.02 to 0.21 | | 0.03 | 0.02 to 0.04 | | 0.03 | 0.02 to 0.07 | | 0.04 | 0.02 to 0.12 | | 35 | 0.03 to 428 | | 218 | 0.02 to 4730 | | 6.68 | 0.06 to 72 | | 1.8 | | |
| Phosphorus, total | 0.17 | 0.02 to 0.48 | | 0.13 | 0.12 to 0.2 | | 0.85 | 0.02 to 3.7 | | 0.03 | 0.02 to 0.07 | | 0.07 | 0.02 to 0.23 | | 0.03 | 0.02 to 0.05 | | 0.15 | 0.02 to 4.6 | | 9.04 | 0.02 to 0.15 | | 60 | 0.02 to 679 | | 187 | 0.02 to 2890 | | 7.33 | 0.06 to 77 | | 3.1 | | |
| Fluoride | 0.5 | 0.2 to 1.0 | | 0.9 | 0.8 to 1.0 | | 0.6 | 0.1 to 1.2 | | 0.7 | 0.2 to 3.1 | | 0.2 | 0.1 to 0.3 | | 0.5 | 0.4 to 0.6 | | 0.7 | 0.2 to 1.0 | | 0.2 | 0.2 to 0.4 | | 1.6 | 0.1 to 11 | | 77 | 0.1 to 2730 | | 0.6 | 0.2 to 1.3 | | 0.7 | | |

(a) 2 S.D. = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

(b) 9.4 pH is thought to be an outlier. 8.9 pH is the upper representative value.

Table 4.4-7
Ranges of Metals Concentrations for All EMF Monitoring Wells

| Parameter (mg/l) | | Unimpacted Wells | | | | | | | | | | | | | | | | | | Representative Concentrations Upper Limit (2 S.D.) (a) | | | | | | |
|------------------|-------|----------------------|------------------|----------|------------------|------------------|------------------|----------------------|------------------|--------------|----------------------|-------------|------------------|-----------------------|------------------|--------------|----------------------|--------------|------|--|----------------------|-----|-----|-----------------------|-----|-----|
| | | PMC Wells | | | | | | Simplex Wells | | | | | | Offsite Wells | | | | | | | | | | | | |
| | | Michael Flats Region | | | Well 138 | | | Barnack Range Region | | | Barnack Range Region | | | Portwood River Region | | | Michael Flats Region | | | | Barnack Range Region | | | Portwood River Region | | |
| | | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | | Mean | Min | Max | Mean | Min | Max |
| Aluminum, | total | 0.07 | 0.05 to 0.11 | ND | ND to ND | ND | 0.15 | 0.02 to 0.50 | 0.09 | 0.02 to 0.40 | 0.59 | 0.02 to 1.9 | 0.04 | 0.02 to 0.07 | 0.03 | 0.02 to 0.06 | 0.10 | 0.02 to 0.93 | 0.68 | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | ND | 0.20 | 0.20 to 0.20 | 0.02 | 0.02 to 0.02 | ND | ND to ND | ND | ND to ND | 0.05 | 0.05 to 0.05 | ND | ND to ND | | | | | | | | | |
| Arsenic, | total | 0.016 | 0.004 to 0.092 | 0.012 | 0.008 to 0.018 | 0.015 | 0.002 to 0.038 | 0.012 | 0.002 to 0.028 | 0.004 | 0.002 to 0.007 | 0.007 | 0.004 to 0.011 | 0.007 | 0.002 to 0.020 | 0.005 | 0.002 to 0.009 | 0.032 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | ND | ND | ND to ND | 0.005 | 0.005 to 0.005 | ND | ND to ND | ND | ND to ND | 0.007 | 0.007 to 0.007 | ND | ND to ND | | | | | | | | | |
| Barium, | total | 0.14 | 0.05 to 0.27 | 0.10 | 0.04 to 0.23 | 0.16 | 0.05 to 2.2 | 0.06 | 0.04 to 0.08 | 0.15 | 0.12 to 0.20 | 0.43 | 0.11 to 2.2 | 0.07 | 0.04 to 0.11 | 0.13 | 0.06 to 0.18 | 0.22 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | ND | 0.08 | 0.08 to 0.08 | 0.06 | 0.06 to 0.06 | ND | ND to ND | ND | ND to ND | 0.06 | 0.05 to 0.07 | ND | ND to ND | | | | | | | | | |
| Beryllium, | total | ND | ND to ND | ND | ND to ND | ND | ND to ND | 0.001 | 0.001 to 0.002 | 0.001 | 0.001 to 0.002 | 0.001 | 0.001 to 0.001 | 0.001 | 0.001 to 0.002 | 0.001 | 0.001 to 0.003 | 0.003 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | ND | 0.004 | 0.004 to 0.004 | 0.001 | 0.001 to 0.001 | ND | ND to ND | ND | ND to ND | ND | ND to ND | ND | ND to ND | | | | | | | | | |
| Boron, | total | 0.25 | 0.05 to 0.63 | 0.77 | 0.64 to 0.99 | 0.21 | 0.05 to 0.53 | 0.10 | 0.04 to 0.19 | 0.14 | 0.09 to 0.25 | 0.19 | 0.07 to 0.41 | 0.11 | 0.06 to 0.18 | 0.15 | 0.09 to 0.25 | 0.36 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | ND | 0.29 | 0.11 to 0.46 | 0.04 | 0.04 to 0.04 | ND | ND to ND | ND | ND to ND | 0.08 | 0.08 to 0.08 | ND | ND to ND | | | | | | | | | |
| Cadmium, | total | ND | ND to ND | ND | ND to ND | ND | ND to ND | 0.001 | 0.000 to 0.001 | 0.001 | 0.000 to 0.001 | 0.001 | 0.001 to 0.001 | 0.001 | 0.000 to 0.001 | 0.001 | 0.000 to 0.001 | 0.006 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | ND | ND | ND to ND | 0.001 | 0.001 to 0.001 | ND | ND to ND | ND | ND to ND | 0.001 | 0.001 to 0.001 | 0.001 | 0.000 to 0.001 | | | | | | | | | |
| Chromium, | total | 0.005 | 0.001 to 0.009 | 0.007 | 0.006 to 0.009 | 0.003 | 0.001 to 0.016 | 0.003 | 0.001 to 0.010 | 0.004 | 0.001 to 0.019 | 0.003 | 0.003 to 0.004 | 0.002 | 0.000 to 0.005 | 0.002 | 0.001 to 0.003 | 0.012 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | 0.002 | 0.002 to 0.002 | 0.001 | 0.001 to 0.001 | ND | ND to ND | ND | ND to ND | ND | ND to ND | ND | ND to ND | | | | | | | | | | |
| Cobalt, | total | 0.008 | 0.006 to 0.015 | 0.043 | 0.042 to 0.045 | 0.021 | 0.003 to 0.034 | 0.003 | 0.003 to 0.003 | 0.003 | 0.003 to 0.003 | 0.007 | 0.003 to 0.014 | 0.005 | 0.003 to 0.014 | 0.006 | 0.003 to 0.017 | 0.033 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | ND | ND | ND to ND | 0.003 | 0.003 to 0.003 | ND | ND to ND | ND | ND to ND | ND | ND to ND | ND | ND to ND | | | | | | | | | |
| Copper, | total | ND | ND to ND | 0.011 | 0.011 to 0.011 | 0.004 | 0.003 to 0.005 | 0.004 | 0.004 to 0.004 | 0.005 | 0.004 to 0.009 | 0.042 | 0.004 to 0.083 | 0.005 | 0.004 to 0.010 | 0.005 | 0.004 to 0.012 | 0.022 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | 0.005 | 0.005 to 0.005 | 0.004 | 0.004 to 0.004 | ND | ND to ND | ND | ND to ND | 0.002 | 0.002 to 0.002 | ND | ND to ND | | | | | | | | | | |
| Iron, | total | 0.05 | 0.01 to 0.17 | 0.10 | 0.08 to 0.11 | 0.36 | 0.01 to 2.5 | 0.10 | 0.06 to 0.30 | 0.38 | 0.03 to 1.3 | 0.06 | 0.05 to 0.07 | 0.59 | 0.05 to 4.4 | 0.30 | 0.07 to 2.00 | 1.1 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | 0.16 | 0.16 to 0.16 | 0.07 | 0.07 to 0.07 | ND | ND to ND | ND | ND to ND | ND | ND to ND | ND | ND to ND | | | | | | | | | | |
| Lithium, | total | 0.056 | 0.036 to 0.071 | 0.118 | 0.090 to 0.137 | 0.043 | 0.012 to 0.077 | 0.028 | 0.005 to 0.064 | 0.035 | 0.031 to 0.039 | 0.048 | 0.026 to 0.074 | 0.039 | 0.013 to 0.075 | 0.029 | 0.022 to 0.039 | 0.062 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | 0.059 | 0.048 to 0.070 | 0.006 | 0.006 to 0.006 | ND | ND to ND | ND | ND to ND | 0.041 | 0.040 to 0.042 | ND | ND to ND | | | | | | | | | | |
| Manganese, | total | 0.008 | 0.002 to 0.028 | 0.013 | 0.003 to 0.023 | 0.282 | 0.001 to 1.46 | 0.006 | 0.001 to 0.016 | 0.051 | 0.001 to 0.174 | 0.003 | 0.001 to 0.006 | 0.011 | 0.001 to 0.081 | 0.002 | 0.001 to 0.004 | 0.078 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | ND | ND to ND | 0.002 | 0.002 to 0.002 | ND | ND to ND | ND | ND to ND | 0.004 | 0.003 to 0.006 | ND | ND to ND | | | | | | | | | | |
| Mercury, | total | 0.0012 | 0.0012 to 0.0012 | 0.0005 | 0.0005 to 0.0005 | 0.0003 | 0.0001 to 0.0009 | 0.0002 | 0.0001 to 0.0007 | 0.0008 | 0.0002 to 0.0024 | 0.0004 | 0.0001 to 0.0009 | 0.0004 | 0.0001 to 0.0020 | 0.0003 | 0.0001 to 0.0015 | 0.0013 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | 0.0002 | 0.0002 to 0.0002 | 0.0001 | 0.0001 to 0.0001 | ND | ND to ND | ND | ND to ND | ND | ND to ND | ND | ND to ND | | | | | | | | | | |
| Nickel, | total | 0.02 | 0.02 to 0.02 | ND | ND to ND | 0.03 | 0.03 to 0.03 | 0.01 | 0.01 to 0.01 | 0.01 | 0.01 to 0.01 | 0.01 | 0.01 to 0.01 | 0.01 | 0.01 to 0.01 | 0.01 | 0.01 to 0.02 | 0.01 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | 0.03 | 0.03 to 0.03 | 0.01 | 0.01 to 0.01 | ND | ND to ND | ND | ND to ND | ND | ND to ND | ND | ND to ND | | | | | | | | | | |
| Selenium, | total | 0.003 | 0.001 to 0.008 | 0.018 | 0.012 to 0.028 | 0.003 | 0.001 to 0.009 | 0.002 | 0.001 to 0.005 | 0.002 | 0.002 to 0.004 | 0.003 | 0.002 to 0.005 | 0.003 | 0.001 to 0.006 | 0.003 | 0.001 to 0.005 | 0.007 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | 0.001 | 0.001 to 0.001 | 0.002 | 0.002 to 0.002 | ND | ND to ND | ND | ND to ND | 0.002 | 0.002 to 0.002 | ND | ND to ND | | | | | | | | | | |
| Thallium, | total | 0.001 | 0.001 to 0.001 | ND | ND to ND | ND | ND to ND | 0.001 | 0.001 to 0.001 | 0.001 | 0.001 to 0.001 | 0.001 | 0.001 to 0.001 | 0.001 | 0.001 to 0.001 | 0.001 | 0.001 to 0.005 | 0.040 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | ND | ND to ND | 0.001 | 0.001 to 0.001 | ND | ND to ND | ND | ND to ND | ND | ND to ND | ND | ND to ND | | | | | | | | | | |
| Vanadium, | total | 0.005 | 0.003 to 0.009 | 0.006 | 0.006 to 0.006 | 0.009 | 0.002 to 0.060 | 0.003 | 0.002 to 0.006 | 0.002 | 0.002 to 0.002 | 0.003 | 0.002 to 0.006 | 0.004 | 0.002 to 0.020 | 0.002 | 0.002 to 0.002 | 0.124 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | 0.060 | 0.060 to 0.060 | 0.002 | 0.002 to 0.002 | ND | ND to ND | ND | ND to ND | 0.005 | 0.005 to 0.005 | ND | ND to ND | | | | | | | | | | |
| Zinc, | total | 0.011 | 0.011 to 0.011 | ND | ND to ND | 0.022 | 0.004 to 0.044 | 0.012 | 0.005 to 0.027 | 0.034 | 0.004 to 0.116 | 0.053 | 0.005 to 0.115 | 0.030 | 0.002 to 0.126 | 0.010 | 0.003 to 0.023 | 0.397 | | | | | | | | |
| dissolved | ND | ND to ND | ND | ND to ND | 0.037 | 0.030 to 0.044 | 0.007 | 0.007 to 0.007 | ND | ND to ND | ND | ND to ND | ND | ND to ND | ND | ND to ND | | | | | | | | | | |

Notes:

ND = Not Detected

(a) 2 S.D. = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

Table 4.4-7 (Cont'd)

| | | Impacted Wells | | | | | | | | | Representative Concentrations (2 S.D.) (a) |
|----------------------------|--|------------------|--------------------------------------|------------------|--------------------------------------|--------------|------------------------------|---------------|-----|-----|--|
| | | PMC Wells | | | Shapiro Wells | | | Offsite Wells | | | |
| Parameter (mg/l) | | Mean | Min | Max | Mean | Min | Max | Mean | Min | Max | |
| Aluminum, total dissolved | | 3.4 ND | 0.02 to 33 ND to ND | 49.04 107.71 | 0.02 to 567 0.02 to 215 | 0.03 ND | 0.02 to 0.08 ND to ND | | | | 0.68 |
| Arsenic, total dissolved | | 0.136 0.039 | 0.002 to 0.909 0.002 to 0.072 | 0.289 0.416 | 0.001 to 0.815 0.085 to 0.722 | 0.027 ND | 0.002 to 0.050 ND to ND | | | | 0.032 |
| Barium, total dissolved | | 0.15 0.08 | 0.01 to 0.80 0.06 to 0.14 | 0.08 0.10 | 0.01 to 0.43 0.03 to 0.34 | 0.13 ND | 0.02 to 0.30 ND to ND | | | | 0.22 |
| Beryllium, total dissolved | | 0.002 ND | 0.001 to 0.002 ND to ND | 0.008 0.011 | 0.001 to 0.083 0.001 to 0.031 | 0.001 ND | 0.001 to 0.002 ND to ND | | | | 0.003 |
| Boron, total dissolved | | 2.4 1.8 | 0.07 to 89 0.37 to 2.32 | 0.67 0.53 | 0.05 to 6.8 0.36 to 0.60 | 0.36 ND | 0.12 to 0.88 ND to ND | | | | 0.36 |
| Cadmium, total dissolved | | 0.003 ND | 0.000 to 0.009 ND to ND | 0.268 1.726 | 0.000 to 3.59 0.001 to 3.45 | 0.002 ND | 0.000 to 0.008 ND to ND | | | | 0.006 |
| Chromium, total dissolved | | 0.004 ND | 0.000 to 0.022 ND to ND | 0.383 0.979 | 0.001 to 7.58 0.002 to 3.91 | 0.001 ND | 0.001 to 0.002 ND to ND | | | | 0.012 |
| Cobalt, total dissolved | | 0.024 0.017 | 0.003 to 0.139 0.008 to 0.021 | 0.016 0.003 | 0.003 to 0.129 0.003 to 0.003 | 0.009 ND | 0.003 to 0.017 ND to ND | | | | 0.033 |
| Copper, total dissolved | | 0.009 0.085 | 0.002 to 0.041 0.004 to 0.166 | 0.095 0.142 | 0.004 to 1.12 0.004 to 0.689 | 0.005 ND | 0.004 to 0.009 ND to ND | | | | 0.022 |
| Iron, total dissolved | | 1.3 0.06 | 0.01 to 29 0.02 to 0.10 | 14.47 33.97 | 0.01 to 154 0.03 to 102 | 0.50 ND | 0.05 to 2.7 ND to ND | | | | 1.1 |
| Lithium, total dissolved | | 0.163 0.074 | 0.021 to 4.30 0.038 to 0.187 | 0.259 0.236 | 0.013 to 0.704 0.144 to 0.379 | 0.067 ND | 0.030 to 0.104 ND to ND | | | | 0.062 |
| Manganese, total dissolved | | 1.96 0.331 | 0.000 to 91.2 0.203 to 0.398 | 0.787 1.318 | 0.001 to 9.60 0.008 to 6.50 | 0.463 ND | 0.001 to 1.207 ND to ND | | | | 0.078 |
| Mercury, total dissolved | | 0.0009 0.0002 | 0.0001 to 0.0043 0.0002 to 0.0002 | 0.0002 0.0002 | 0.0001 to 0.0011 0.0002 to 0.0003 | 0.0001 ND | 0.0001 to 0.0003 ND to ND | | | | 0.0013 |
| Nickel, total dissolved | | 0.03 ND | 0.01 to 0.08 ND to ND | 0.42 1.07 | 0.01 to 3.5 0.01 to 2.1 | 0.03 ND | 0.01 to 0.09 ND to ND | | | | 0.01 |
| Selenium, total dissolved | | 0.050 0.007 | 0.001 to 0.534 0.002 to 0.014 | 0.025 0.020 | 0.001 to 0.200 0.003 to 0.049 | 0.005 ND | 0.002 to 0.019 ND to ND | | | | 0.007 |
| Thallium, total dissolved | | 0.001 ND | 0.001 to 0.002 ND to ND | 0.008 0.007 | 0.001 to 0.112 0.001 to 0.012 | 0.001 ND | 0.001 to 0.004 ND to ND | | | | 0.040 |
| Vanadium, total dissolved | | 0.036 0.005 | 0.003 to 0.222 0.005 to 0.006 | 1.674 4.376 | 0.002 to 22.3 0.002 to 13.1 | 0.015 ND | 0.002 to 0.140 ND to ND | | | | 0.124 |
| Zinc, total dissolved | | 0.038 ND | 0.004 to 0.110 ND to ND | 2.952 8.711 | 0.002 to 28.9 0.012 to 17.4 | 0.015 ND | 0.004 to 0.041 ND to ND | | | | 0.397 |

Notes:

ND = Not Detected

(a) 2 S.D. = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

Section 4: Nature and Extent of Constituents of Potential Concern

Table 4.4-8
Constituents Found at or Below Representative Concentrations
in Groundwater Beneath the FMC Facility

| | ALL MONITORING WELLS WITHIN FMC FACILITY | | | | REPRESENTATIVE WELLS (16 WELLS) | |
|--|---|------------------------|--|-----|------------------------------------|----------------------|
| Parameter | Number of Samples Analyzed: 274 | | | | Mean | Range (2 S.D.)(b) |
| | Mean | Range (a) Min. Max. | | NOS | | |
| <u>COMMON IONS (in mg/l)</u> | | | | | | |
| Alkalinity, carbonate | 0.0 | 0.0 to 0.0 | | 257 | 1.2 | ND to 5 |
| <u>INORGANICS-METALS (in mg/l)</u> | | | | | | |
| <u>Metals Present in Groundwater in EMF Study Area within Representative Concentrations</u> | | | | | | |
| Antimony | 0.09 | 0.06 to 0.11 | | 2 | 0.12 | 0.04 to 0.20 |
| Lead | 0.006 | 0.002 to 0.016 | | 11 | 0.002 | ND to 0.006 |
| Molybdenum | 0.03 | 0.01 to 0.07 | | 53 | 0.03 | ND to 0.07 |
| Silver | 0.002 | 0.002 to 0.011 | | 68 | 0.004 | 0.002 to 0.006 |
| <u>Metals Present in Groundwater in EMF Study Area Detected at Concentrations occasionally above Representative Concentrations</u> | | | | | | |
| Barium | 0.15 | 0.01 to 2.2 | | 249 | 0.12 | 0.02 to 0.22 |
| Mercury | 0.0008 | 0.0001 to 0.0043 | | 26 | 0.0006 | ND to 0.0013 |
| <u>Additional Metals Present in Groundwater beneath the FMC Facility within Representative Concentrations</u> | | | | | | |
| Beryllium | 0.002 | 0.001 to 0.002 | | 11 | 0.002 | 0.0007 to 0.003 |
| Thallium | 0.001 | 0.001 to 0.002 | | 4 | 0.040 | 0.040 to 0.040 |
| Zinc | 0.03 | 0.004 to 0.110 | | 15 | 0.059 | ND to 0.397 |
| <u>Additional Metals Detected in Groundwater beneath the FMC Facility near Detection Limits or Representative Concentrations</u> | | | | | | |
| Cadmium | 0.003 | 0.0001 to 0.009 | | 11 | 0.003 | 0.001 to 0.006 |
| Chromium | 0.004 | 0.0003 to 0.022 | | 95 | 0.005 | ND to 0.012 |
| Nickel | 0.03 | 0.01 to 0.08 | | 39 | 0.01 | 0.01 to 0.01 |
| <u>ORGANIC COMPOUNDS (in mg/l)</u> | | | | | | |
| Generally not detected (see Table 4.4-5 for details) | | | | | | |

- (a) Min = Minimum detected value, Max = Maximum, NOS = Number of samples in which parameter was detected.
- (b) S.D. = Standard Deviation. Range is \pm two times Standard Deviation.
- ND = Results for all samples below detection limit.

Table 4.4-9
Concentrations of Site-Related Metals in Groundwater Beneath the FMC Facility

| | Former Ponds/8S Area (Includes Southwestern Area former Ponds 1E-6E, 5S-7S, and and 10S and Central Area former Ponds 1S-3S) | | | | | Slag Pit Area (Includes Railroad Swale) | | | | | Representative Concentrations |
|--|---|----------|--------|-------|-----|--|----------|-------|-------|-----|----------------------------------|
| | Michaud Flat Wells 111,122, 135, 137, 140, 159, TW-5S Bannock Range Wells 103, 104, 113, 114, 115, 117, 118, 131, 132, 133, 134, 141, 150, 151, 152 Undetermined Regime Well 116 | | | | | Michaud Flats Well 121 Bannock Range Wells 108, 146 | | | | | Upper Limit (2 S.D.) (a) |
| | Number of Analyses: 108 | | | | | Number of Analyses: 15 | | | | | |
| Parameter (in mg/l) | Mean | (±SD) | Min | Max | NDS | Mean | (±SD) | Min | Max | NDS | |
| Arsenic, total | 0.096 | (±0.066) | 0.008 | 0.252 | 96 | 0.025 | (±0.010) | 0.008 | 0.043 | 13 | 0.032 |
| dissolved | 0.045 | (±0.023) | 0.002 | 0.072 | 6 | ND | | ND | ND | 0 | |
| Boron, total | 3.1 | (±12) | 0.07 | 89 | 98 | 0.54 | (±0.24) | 0.23 | 1.0 | 15 | 0.36 |
| dissolved | 2.1 | (±0.33) | 1.5 | 2.3 | 5 | ND | | ND | ND | 0 | |
| Cobalt, total | 0.029 | (±0.031) | 0.003 | 0.139 | 65 | 0.006 | (±0.002) | 0.004 | 0.010 | 9 | 0.033 |
| dissolved | 0.018 | (±0.006) | 0.008 | 0.021 | 5 | ND | | ND | ND | 0 | |
| Copper, total | 0.007 | (±0.007) | 0.002 | 0.041 | 31 | 0.005 | (±0.000) | 0.005 | 0.005 | 3 | 0.022 |
| dissolved | 0.085 | (±0.115) | 0.004 | 0.166 | 2 | ND | | ND | ND | 0 | |
| Lithium, total | 0.146 | (±0.437) | 0.025 | 4.30 | 94 | 0.069 | (±0.013) | 0.051 | 0.092 | 13 | 0.062 |
| dissolved | 0.076 | (±0.063) | 0.038 | 0.187 | 5 | ND | | ND | ND | 0 | |
| Manganese, total | 2.58 | (±9.36) | 0.0002 | 91.2 | 96 | 0.391 | (±0.283) | 0.050 | 0.832 | 14 | 0.078 |
| dissolved | 0.334 | (±0.072) | 0.203 | 0.398 | 6 | ND | | ND | ND | 0 | |
| Selenium, total | 0.006 | (±0.006) | 0.001 | 0.026 | 48 | 0.030 | (±0.085) | 0.002 | 0.312 | 13 | 0.007 |
| dissolved | 0.005 | (±0.004) | 0.002 | 0.011 | 4 | ND | | ND | ND | 0 | |
| Vanadium, total | 0.012 | (±0.009) | 0.003 | 0.042 | 33 | 0.016 | (±0.005) | 0.010 | 0.020 | 3 | 0.124 |
| dissolved | 0.005 | (±0.000) | 0.005 | 0.006 | 2 | ND | | ND | ND | 0 | |
| Parameters Related to the Presence of Silt or to Well Construction Materials | | | | | | | | | | | |
| Aluminum, total | 4.4 | (±10) | 0.02 | 33 | 17 | 0.04 | (±0.02) | 0.02 | 0.05 | 2 | 0.68 |
| dissolved | ND | | ND | ND | 0 | ND | | ND | ND | 0 | |
| Iron, total | 1.6 | (±5.6) | 0.01 | 29 | 46 | 0.03 | (±0.02) | 0.02 | 0.05 | 4 | 1.1 |
| dissolved | 0.06 | (±0.06) | 0.02 | 0.10 | 2 | ND | | ND | ND | 0 | |

Abbreviations: SD = Standard Deviation, Min = minimum, Max = maximum, NOS = number of samples in statistical calculations (Samples with concentrations below detection limit — with "U" qualifier — not included), ND = below detection limit

NOA = number of samples analyzed

(a) 2 S.D. = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

(b) Secondary Standard NR = Not currently regulated.

Table 4.4-10
Nutrient and Fluoride Concentrations in Impacted Groundwater at FMC

| | Former Ponds/BS Area (Includes Southwestern Area former Ponds 1E-6E, 5S-7S, and 10S and Central Area former Ponds 1S-3S) | | | | | Slag Pit Area (Includes Railroad Swale) | | | | | Representative Concentrations |
|--|--|--------|------|-----|-----|--|---------|------|------|-----|-------------------------------|
| | Michaud Flat Wells 111,122, 135, 137, 140, 159, TW-5S Bannock Range Wells 103, 104, 113, 114, 115, 117, 118, 131, 132, 133, 134, 141, 150, 151, 152 Undetermined Regime Well 116 | | | | | Michaud Flats Well 121 Bannock Range Wells 108, 146 | | | | | Upper Limit (2 S.D.) (a) |
| | Number of Analyses: 102 | | | | | Number of Analyses: 14 | | | | | |
| Parameter (in mg/l) | Mean | (±SD) | Min | Max | NOS | Mean | (±SD) | Min | Max | NOS | |
| Ammonia (NH ₃ as N) | 3.4 | (±3.4) | 0.3 | 11 | 46 | ND | | ND | ND | 0 | 0.8 |
| Nitrate (NO ₃ as N) | 7.7 | (±9.0) | 0.1 | 32 | 74 | 15 | (±9.2) | 4.1 | 30 | 14 | 4.5 |
| Orthophosphate (PO ₄ as P) | 40 | (±100) | 0.03 | 428 | 98 | 0.49 | (±0.21) | 0.20 | 0.90 | 13 | 1.8 |
| Phosphorus, total | 75 | (±174) | 0.02 | 679 | 98 | 0.55 | (±0.24) | 0.11 | 0.88 | 14 | 3.1 |
| Fluoride | 1.9 | (±2.9) | 0.1 | 11 | 83 | 1.7 | (±1.1) | 0.7 | 4.5 | 14 | 0.7 |

Abbreviations: SD = Standard Deviation, Min = minimum, Max = maximum, NOS = number of samples in statistical calculations (Samples with concentrations below detection limit — with "U" qualifier — not included), ND = below detection limit
 NOA = number of samples analyzed

(a) 2 S.D. = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

Table 4.4-11
Common Ion and Physical Parameter Concentrations in Groundwater at FMC

| | Former Ponds/8S Area (Includes Southwestern Area former Ponds 1E-6E, 5S-7S, and and 10S and Central Area former Ponds 1S-3S) | | | | | Slag Pit Area (Includes Railroad Swale) | | | | | Representative Concentrations |
|------------------------------------|---|---------|------|------|-----|--|---------|------|------|-----|----------------------------------|
| | Michaud Flat Wells 111,122, 135, 137, 140, 159, TW-5S Bannock Range Wells 103, 104, 113, 114, 115, 117, 118, 131, 132, 133, 134, 141, 150, 151, 152 Undetermined Regime Well 116 | | | | | Michaud Flats Well 121 Bannock Range Wells 108, 146 | | | | | Upper Limit (2 S.D.) (a) |
| Parameter (in mg/l) | Mean | (±SD) | Min | Max | NOS | Mean | (±SD) | Min | Max | NOS | |
| Common Ions | | | | | | | | | | | |
| Alkalinity, bicarbonate (mg/l) | 527 | (±350) | 196 | 1560 | 102 | 293 | (±56) | 228 | 387 | 14 | 315 |
| Calcium (mg/l) | 100 | (±54.4) | 29.8 | 294 | 101 | 102 | (±20.0) | 68.6 | 134 | 14 | 105 |
| Chloride (mg/l) | 232 | (±126) | 50 | 644 | 101 | 168 | (±47) | 89.0 | 234 | 14 | 177 |
| Magnesium (mg/l) | 55.4 | (±24.9) | 10.6 | 119 | 102 | 168 | (±6.3) | 26.8 | 47.7 | 14 | 42 |
| Potassium (mg/l) | 207 | (±346) | 5.5 | 1400 | 98 | 139 | (±55) | 59.4 | 226 | 14 | 13 |
| Sodium (mg/l) | 247 | (±207) | 24.6 | 1110 | 99 | 105 | (±30) | 69.2 | 161 | 13 | 64 |
| Sulfate (mg/l) | 196 | (±137) | 81 | 905 | 102 | 211 | (±75) | 120 | 316 | 14 | 79 |
| Physical Parameters | | | | | | | | | | | |
| pH | | | 6.46 | 7.80 | 102 | | | 6.69 | 7.20 | 14 | 69 to 9.4(b) |
| Specific Conductance (µmhos/cm) | 2241 | (±1304) | 819 | 6346 | 102 | 1679 | (±394) | 1132 | 2218 | 14 | 1052 |
| Temperature (°C) | 15.2 | (±2.9) | 10.5 | 22.9 | 102 | 23.8 | (±4.7) | 18.4 | 30.0 | 14 | 11.4 to 17.9 |
| TDS (mg/l) | 1574 | (±1114) | 500 | 5220 | 102 | 1086 | (±281) | 700 | 1440 | 14 | 746 |
| Redox (mV) | 38 | (±147) | -306 | 224 | 36 | 110 | (±126) | -45 | 221 | 5 | |

Abbreviations: SD = Standard Deviation, Min = minimum, Max = maximum, NOS = number of samples in statistical calculations (Samples with concentrations below detection limit — with "U" qualifier — not included), ND = below detection limit

NOA = number of samples analyzed

(a) 2 S.D. = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

Table 4.4-12
Activities of Radiological Parameters in Groundwater at FMC

| | | Representative Concentrations/Unimpacted Areas | | | | | | | | | |
|-------------|----------------|--|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| | | Michael Field Region | | | | | | | | | |
| Parameter | Sampling Event | Representative Wells | | 147 | TW-188 | 112 | 126 | 127 | 128 | 139 | 148 |
| | | 181 | 182 | | | | | | | | |
| Gross alpha | Jun-92 | 2.6 ±1.9 | ND | ND | 3.4 ±3.0 | ND | ND | ND | ND | ND | ND |
| Gross alpha | Jul-92 | | | | | | | | | | |
| Gross alpha | Sep-92 | 4.40 ±2.45 | 2.28 ±1.87 | 2.64 ±0.40 | 3.43 ±0.36 | 2.2 ±1.4 | 2.4 ±0.38 | ND | ND | 2.65 ±0.56 | 4.23 ±2.79 |
| Gross alpha | Dec-92 | 7.34 ±2.38 | 4.50 ±1.72 | 5.18 ±1.14 | 5.36 ±2.52 | 2.95 ±0.40 | ND | 2.19 ±1.16 | ND | ND | 6.57 ±1.04 |
| Gross alpha | Mar-93 | 2.94 ±1.60 | 3.94 ±1.24 | 4.39 ±1.05 | 5.82 ±2.07 | ND | ND | ND | ND | 2.27 ±2.95 | 3.31 ±1.00 |
| Gross alpha | Jul-93 | 3.54 ±0.78 | 2.54 ±0.57 | 3.97 ±0.95 | 7.97 ±1.37 | ND | ND | ND | ND | ND | 5.58 ±1.06 |
| Gross beta | Jun-92 | 4.1 ±2.9 | 6.5 ±3.0 | 20.6 ±3.50 | 6.1 ±3.40 | ND | 11.8 ±3.30 | 8.3 ±3.00 | 15.9 ±3.4 | 22.1 ±4.0 | 5.8 ±3.4 |
| Gross beta | Jul-92 | | | | | | | | | | |
| Gross beta | Sep-92 | 8.11 ±1.81 | 6.97 ±1.74 | 14.3 ±0.48 | 8.27 ±0.39 | 8.40 ±1.80 | 10.2 ±0.41 | 15 ±0.72 | 14.0 ±0.51 | 36.6 ±1.74 | 10.8 ±1.93 |
| Gross beta | Dec-92 | 9.77 ±1.35 | 9.53 ±1.46 | 10.8 ±0.94 | 10.1 ±1.49 | 6.59 ±0.42 | 9.74 ±1.64 | 7.57 ±1.27 | 9.02 ±0.46 | 41.4 ±1.48 | 9.57 ±0.91 |
| Gross beta | Mar-93 | 45.8 ±2.65 | 7.51 ±0.98 | 9.85 ±1.01 | 7.05 ±0.96 | 5.77 ±1.16 | ND | 10.1 ±1.61 | 12.4 ±1.89 | 37.4 ±5.24 | 9.77 ±1.03 |
| Gross beta | Jul-93 | 7.14 ±0.79 | 5.82 ±0.73 | 8.91 ±0.90 | 9.58 ±0.89 | ND | ND | ND | ND | ND | 10.4 ±0.88 |
| Radium-226 | Sep-92 | ND | ND | ND | 6.35 ±0.57 | 1.57 ±0.44 | 2.28 ±0.53 | ND | 7.09 ±0.82 | ND | 3.19 ±0.50 |
| Radium-226 | Dec-92 | ND | ND | ND | ND | ND | ND | ND | 1.01 ±0.20 | ND | ND |
| Radium-226 | Mar-93 | ND | ND | 1.82 ±0.26 | ND | 2.3 ±0.23 | ND | ND | 1.40 ±0.23 | ND | ND |
| Radium-226 | Jul-93 | 1.87 ±0.34 | 1.84 ±0.23 | ND | ND | ND | ND | ND | ND | ND | 3.81 ±0.51 |
| Radium-228 | Sep-92 | 1.2 ±0.8 | 1.8 ±0.9 | ND | 4.2 ±1.0 | ND | ND | ND | 1.3 ±0.8 | ND | ND |
| Radium-228 | Dec-92 | ND | 6.5 ±1.2 | ND | ND | ND | 1.4 ±0.9 | 7.8 ±1.4 | 1.1 ±0.9 | ND | ND |
| Radium-228 | Mar-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Radium-228 | Jul-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

| | | Representative Concentrations/Unimpacted Areas | | | | | | | | | | | | | | | |
|-------------|----------------|--|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------|------------|------------|------------|------------|------------|
| | | Hannock Range Region | | | | | | | | | | | | | | | |
| Parameter | Sampling Event | Representative Wells | | | 187 | 189 | 119 | 124 | 125 | 129 | 148 | 153 | 154 | FMC-8 | TW-30 | TW-50 | TW-51 |
| | | 186 | 128 | 138 | | | | | | | | | | | | | |
| Gross alpha | Jun-92 | ND | ND | 3.7 ±2.4 | ND | 12.2 ±2.7 | ND | ND | 3.7 ±2.3 | ND | ND | 2.4 ±2.0 | NS | NS | ND | ND | ND |
| Gross alpha | Jul-92 | | | | | | | | | | | | | | | | |
| Gross alpha | Sep-92 | 4.59 ±1.95 | ND | ND | 2.92 ±0.74 | 8.12 ±1.21 | ND | ND | ND | 2 ±1.60 | ND | NS | NS | 2.8 ±1.8 | 2.8 ±1.40 | ND | ND |
| Gross alpha | Dec-92 | 3.76 ±0.96 | ND | 3.74 ±1.94 | 3.14 ±0.91 | 3.20 ±0.60 | ND | 3.12 ±1.83 | 3.48 ±1.47 | ND | ND | NS | NS | 5.92 ±1.51 | 2.8 ±0.89 | ND | ND |
| Gross alpha | Mar-93 | ND | 3.5 ±3.89 | 3.14 ±1.08 | 4.49 ±1.20 | 2.59 ±1.05 | ND | ND | ND | ND | 2.46 ±1.54 | NS | NS | 4.20 ±1.60 | 5.94 ±1.54 | 2.8 ±1.05 | ND |
| Gross alpha | Jul-93 | ND | ND | ND | ND | 2.27 ±0.57 | ND | ND | ND | ND | 2.13 ±0.70 | NS | NS | 5.10 ±1.13 | 3.43 ±0.60 | ND | ND |
| Gross beta | Jun-92 | ND | 3.8 ±3.5 | 7.4 ±3.5 | 6.7 ±3.6 | 22.9 ±3.8 | 6.3 ±3.6 | 10.4 ±3.2 | 10.2 ±3.2 | 7.2 ±3.5 | 9.4 ±3.6 | 11.7 ±3.0 | NS | NS | ND | ND | ND |
| Gross beta | Jul-92 | | | | | | | | | | | | | | | | |
| Gross beta | Sep-92 | 9.04 ±1.82 | 9.53 ±1.75 | 8.9 ±1.80 | 6.70 ±1.19 | 4.34 ±1.23 | 11.1 ±1.81 | 14 ±0.49 | 5.85 ±1.69 | ND | 7.90 ±0.37 | NS | NS | 8.0 ±1.7 | 9.5 ±1.8 | 10.5 ±1.8 | 7.1 ±1.5 |
| Gross beta | Dec-92 | 8.43 ±0.76 | 5.22 ±0.41 | 7.64 ±1.37 | ND | 8.9 ±0.71 | 9.48 ±0.47 | 11.5 ±1.40 | 6.69 ±1.27 | 24.5 ±1.95 | 9.08 ±1.36 | NS | 9.01 ±1.30 | NS | 8.23 ±1.31 | 7.78 ±1.05 | 5.75 ±0.85 |
| Gross beta | Mar-93 | 7.18 ±1.15 | 30 ±5.12 | 7.3 ±1.72 | 7.83 ±1.77 | 1.57 ±1.03 | 11.6 ±3.86 | 8.26 ±1.17 | 7.10 ±1.20 | 6.24 ±1.76 | 8.26 ±1.01 | NS | 8.24 ±1.00 | NS | 9.06 ±1.27 | 4.63 ±1.82 | ND |
| Gross beta | Jul-93 | ND | ND | ND | ND | 4.73 ±0.65 | ND | ND | ND | ND | 8.40 ±0.81 | NS | 8.10 ±0.88 | NS | 6.67 ±0.70 | ND | ND |
| Radium-226 | Sep-92 | ND | 1.55 ±0.42 | ND | ND | ND | ND | ND | ND | ND | ND | NS | NS | NS | ND | ND | ND |
| Radium-226 | Dec-92 | ND | ND | ND | ND | ND | ND | ND | ND | 1.35 ±0.21 | ND | NS | NS | NS | ND | ND | ND |
| Radium-226 | Mar-93 | ND | ND | ND | 2.24 ±0.27 | ND | ND | ND | ND | ND | NS | NS | NS | NS | ND | 2.21 ±0.27 | ND |
| Radium-226 | Jul-93 | ND | ND | ND | ND | 3.83 ±0.50 | ND | ND | ND | ND | 1.15 ±0.34 | NS | 1.06 ±0.30 | NS | ND | ND | ND |
| Radium-228 | Sep-92 | 1.0 ±0.8 | ND | ND | ND | ND | 10.7 ±1.1 | ND | ND | ND | ND | NS | NS | NS | ND | ND | ND |
| Radium-228 | Dec-92 | ND | 1.3 ±0.7 | ND | ND | 3.0 ±1.0 | ND | ND | ND | ND | ND | NS | 5.6 ±1.3 | NS | 7.2 ±1.3 | ND | ND |
| Radium-228 | Mar-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NS | ND | NS | ND | ND | ND |
| Radium-228 | Jul-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.8 ±1.2 | NS | 1.9 ±0.9 | NS | ND | ND | ND |

Table 4.4-12 (Continued)

| | | Former Ponds/SS Area (includes Southwestern Area former Ponds 11-46, 48-78, and 103 and Central Area former Ponds 10-36) | | | | | | | Savonick Range Basins | | | | | | | | | | | | | Undetermined Range | |
|---------------------|----------------|--|------------|------------|------------|------------|------------|------------|-----------------------|------------|------------|------------|------------|------------|------------|-------------|------------|------------|------------|-------------|------------|--------------------|-----------|
| Michael Flak Basins | | | | | | | | | | | | | | | | | | | | | | | |
| Parameter | Sampling Event | 111 | 122 | 135 | 137 | 148 | TW-58 | 183 | 184 | 118 | 114 | 115 | 117 | 118 | 121 | 132 | 133 | 134 | 141 | 158 | 151 | 152 | 118 |
| Gross alpha | Jun-92 | 25.9 ±6.1 | 16.8 ±7.6 | ND | ND | 11.5 ±6.9 | ND | ND | ND | ND | ND | ND | ND | ND | ND | 11.5 ±8.00 | ND | 10.1 ±7.90 | ND | 33.1 ±11.0 | ND | 2.5 ±2.00 | ND |
| Gross alpha | Jul-92 | ND | ND | ND | ND | 6.05 ±0.90 | ND | 3.39 ±0.38 | 7.22 ±1.69 | ND | 2.84 ±0.61 | 2.12 ±0.34 | 5.96 ±2.11 | ND | 4.64 ±0.61 | ND | 2.1 ±1.47 | ND | ND | ND | 2.48 ±1.52 | ND | |
| Gross alpha | Sep-92 | ND | ND | ND | 2.06 ±1.47 | 6.54 ±1.50 | ND | 3.05 ±0.30 | 2.19 ±1.23 | 4.78 ±0.53 | ND | 2.27 ±0.23 | 8.05 ±0.62 | ND | 6.09 ±0.56 | 4.63 ±1.04 | 8.76 ±1.29 | ND | ND | 11.2 ±6.95 | ND | 41.2 ±11.90 | ND |
| Gross alpha | Dec-92 | ND | ND | ND | ND | 4.52 ±2.23 | ND | 4.65 ±1.28 | 2.87 ±2.22 | ND | ND | 2.19 ±2.15 | 10.1 ±2.10 | ND | 3.38 ±1.66 | ND | 5.14 ±1.43 | ND | ND | ND | ND | ND | ND |
| Gross alpha | Mar-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 5 ±1.76 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Gross alpha | Jul-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Gross beta | Jun-92 | 108.1 ±6.5 | 155.1 ±8.2 | ND | 7.8 ±2.90 | 24.9 ±4.2 | 119.4 ±7.9 | 7.1 ±3.5 | 260.9 ±10.0 | 26.9 ±3.9 | ND | ND | 13 ±3.9 | 18.8 ±4.2 | 14.4 ±3.8 | 148.6 ±8.00 | 15.9 ±3.90 | 120 ±7.30 | 19.7 ±3.90 | 407.8 ±12.7 | ND | 355.2 ±11.2 | 92.4 ±6.2 |
| Gross beta | Jul-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Gross beta | Sep-92 | 80.8 ±1.41 | 171 ±4.67 | 14 ±1.95 | 7.89 ±0.56 | 38 ±1.22 | 167 ±2.52 | 12.8 ±0.82 | 384 ±5.11 | 29.8 ±0.71 | 7.83 ±0.88 | 10.8 ±1.37 | 18.5 ±2.10 | 27.8 ±1.35 | 15.4 ±0.81 | 240 ±4.23 | 10.1 ±1.79 | 181 ±2.46 | 21 ±1.59 | 1110 ±11.1 | 16.3 ±2.0 | 508 ±6.36 | 145 ±3.18 |
| Gross beta | Dec-92 | 94.0 ±3.73 | 158 ±3.21 | 12 ±0.93 | 4.48 ±1.21 | 26.5 ±1.73 | 163 ±3.57 | 18.7 ±0.60 | 325 ±3.99 | 27.9 ±0.66 | 8.7 ±2.54 | ND | 14.6 ±0.58 | 22.1 ±0.99 | ND | 196 ±3.26 | 21.3 ±1.03 | 144 ±4.33 | 19.8 ±0.98 | 334 ±11.3 | 18.4 ±1.7 | 80.6 ±8.17 | 125 ±2.64 |
| Gross beta | Mar-93 | 115 ±5.35 | 162 ±4.78 | 12.3 ±1.94 | 5.66 ±1.70 | 21.4 ±3.38 | 174 ±6.26 | 11.0 ±1.72 | 300 ±11.0 | 23.7 ±1.51 | 7.63 ±1.69 | 11.0 ±3.42 | 15.6 ±1.84 | 81.4 ±3.06 | 8.35 ±2.78 | 176 ±9.17 | 16.2 ±1.96 | 139 ±5.61 | 15.7 ±1.64 | 1100 ±27.3 | 19.2 ±2.0 | 991 ±27.3 | 300 ±10.7 |
| Gross beta | Jul-93 | ND | ND | ND | ND | ND | ND | ND | ND | 14.9 ±1.65 | 6.57 ±1.24 | 6.67 ±1.34 | ND | ND | ND | ND | ND | ND | ND | 938 ±19.9 | ND | 783 ±18.0 | ND |
| Radium-226 | Sep-92 | 2.50 ±0.50 | 2.76 ±0.57 | ND | ND | ND | ND | ND | ND | 2.39 ±0.37 | ND | ND | ND | 3.27 ±0.42 | ND | ND | ND | ND | ND | 1.94 ±0.35 | 1.09 ±0.35 | ND | ND |
| Radium-226 | Dec-92 | ND | ND | ND | 1.53 ±0.20 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Radium-226 | Mar-93 | ND | ND | 3.77 ±0.36 | ND | ND | ND | ND | 1.15 ±0.18 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Radium-226 | Jul-93 | ND | ND | ND | ND | ND | ND | ND | ND | 2.2 ±0.42 | ND | 1.96 ±0.43 | ND | ND | ND | ND | ND | ND | ND | 1.32 ±0.36 | ND | ND | ND |
| Radium-228 | Sep-92 | ND | 6.2 ±1.3 | ND | ND | ND | ND | ND | ND | ND | ND | 2.7 ±0.90 | ND | ND | ND | ND | 1.6 ±0.90 | 1.1 ±0.70 | ND | ND | ND | 1.7 ±0.8 | ND |
| Radium-228 | Dec-92 | ND | ND | 8.1 ±1.3 | ND | ND | 1.1 ±0.9 | 3.1 ±0.8 | 4.3 ±1.0 | 1.3 ±0.8 | ND | 2.0 ±0.8 | ND | ND | 1.6 ±0.8 | ND | ND | ND | ND | ND | ND | ND | ND |
| Radium-228 | Mar-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 3.0 ±1.0 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Radium-228 | Jul-93 | ND | ND | ND | ND | ND | ND | ND | ND | 1.4 ±0.8 | 1.5 ±1.0 | 6.0 ±1.2 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

| | | Savonick Range Basins | | |
|-------------|----------------|-----------------------|------------|------------|
| Parameter | Sampling Event | 121 | 188 | 188 |
| Gross alpha | Jun-92 | ND | 11.2 ±8.3 | 17.6 ±3.8 |
| Gross alpha | Jul-92 | ND | 2.12 ±0.82 | ND |
| Gross alpha | Sep-92 | ND | 3.94 ±2.33 | ND |
| Gross alpha | Dec-92 | ND | 4.15 ±1.60 | ND |
| Gross alpha | Mar-93 | 7.88 ±2.25 | ND | ND |
| Gross alpha | Jul-93 | ND | ND | ND |
| Gross beta | Jun-92 | 89.2 ±6.6 | 105.3 ±7.0 | 66.4 ±5.4 |
| Gross beta | Jul-92 | ND | ND | ND |
| Gross beta | Sep-92 | 119 ±1.73 | 186 ±2.22 | 85.1 ±2.53 |
| Gross beta | Dec-92 | 99.8 ±2.57 | 154 ±4.92 | 41.7 ±1.67 |
| Gross beta | Mar-93 | 3.27 ±1.60 | 145 ±5.21 | 52.6 ±2.58 |
| Gross beta | Jul-93 | ND | ND | ND |
| Radium-226 | Sep-92 | ND | ND | ND |
| Radium-226 | Dec-92 | ND | ND | ND |
| Radium-226 | Mar-93 | ND | ND | 1.79 ±0.28 |
| Radium-226 | Jul-93 | ND | ND | ND |
| Radium-228 | Sep-92 | 2.8 ±1.1 | ND | 7.2 ±1.3 |
| Radium-228 | Dec-92 | ND | ND | ND |
| Radium-228 | Mar-93 | ND | ND | ND |
| Radium-228 | Jul-93 | ND | ND | ND |

ND = Below detection limit/not detected.
 NS = Not sampled.

Table 4.4-13
Organic Compounds Detected in Groundwater at FMC

| PARAMETER | SAMPLING EVENT | Representative Concentrations/Unimpacted Areas | | | | | | Former Ponds/8S Area (Includes Southwestern Area former Ponds 1E-6E, 5S-7S, and Central Area former Ponds 1S-3S) | | | | | | | | Slag Pit Area (Includes Railroad Swale) | | | Practical Quantitation Limits (mg/l) |
|--|-------------------|--|-------|--------|-------|----------------------------|------------------------|--|-------|-------|-------|----------------------|-------|-------|-------|--|-------------------------|-------|---|
| | | Michaud Flats Regime | | | | Bannock Range Regime | Undetermined Regime | Michaud Flats Regime | | | | Bannock Range Regime | | | | Michaud Flats Regime | Bannock Range Regime | | |
| | | 101 | 102 | TW-10S | 112 | Representative Well 106 | 139 | 111 | 135 | 140 | TW-5S | 104 | 134 | 141 | 150 | 121 | 108 | 146 | |
| <u>VOLATILE ORGANIC COMPOUNDS</u> | | | | | | | | | | | | | | | | | | | |
| 2-Butanone | Jun-92 | ND | ND | ND | ND | ND | 0.007 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.1 |
| 2-Butanone | Mar-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.01 | ND | |
| Chlorobenzene | Jun-92 | 0.001 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.005 |
| Chloroform | Jun-92 | ND | ND | ND | ND | ND | ND | 0.001 | ND | ND | ND | ND | ND | ND | ND | 0.001 | ND | ND | 0.005 |
| Ethyl benzene | Jun-92 | ND | ND | ND | ND | ND | ND | ND | 0.001 | ND | ND | ND | ND | ND | ND | ND | ND | 0.002 | 0.005 |
| Tetrachloroethene | Jun-92 | ND | ND | ND | ND | ND | ND | 0.035 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.005 |
| Toluene | Jun-92 | ND | ND | ND | ND | ND | ND | ND | ND | 0.002 | ND | 0.001 | ND | ND | ND | 0.002 | ND | ND | 0.005 |
| Toluene | Sep-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.001 | 0.004 | ND | |
| Trichloroethene | Jun-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.015 | 0.003 | 0.003 | 0.005 |
| Trichloroethene | Sep-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.01 | 0.002 | 0.002 | |
| Trichloroethene | Dec-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.008 | ND | ND | |
| Xylenes, total | Jun-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.005 |
| Xylenes, total | Sep-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.002 | ND | ND | |
| Xylenes, total | Dec-92 | ND | ND | 0.001 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | |
| <u>SEMIVOLATILE ORGANIC COMPOUNDS</u> | | | | | | | | | | | | | | | | | | | |
| Bis(2-ethylhexyl)phthalate | Jun-92 | ND | ND | ND | 0.003 | ND | ND | ND | ND | ND | ND | 0.003 | ND | ND | ND | 0.002 | 0.005 | ND | 0.01 |
| Bis(2-ethylhexyl)phthalate | Sep-92 | 0.004 | 0.002 | 0.004 | 0.003 | 0.005 | 0.003 | 0.006 | 0.006 | 0.005 | 0.012 | ND | 0.006 | 0.004 | ND | 0.008 | 0.015 | 0.003 | |
| Bis(2-ethylhexyl)phthalate | Dec-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 0.039 | ND | ND | 0.017 | 0.019 | ND | |
| Di-n-butyl phthalate | Dec-92 | ND | ND | ND | 0.001 | ND | ND | ND | ND | 0.001 | ND | ND | ND | ND | 0.002 | ND | ND | ND | 0.01 |
| Dimethyl phthalate | Dec-92 | ND | ND | ND | ND | ND | ND | ND | 0.067 | ND | 0.005 | 0.024 | 0.053 | ND | 0.054 | 0.088 | ND | ND | 0.01 |

ND = Below detection limit/not detected.

Table 4.4-14
Mean Concentrations (mg/l) of Metals in Groundwater – Eastern Simplot Area

| Well Designation | Wells in vicinity of gypsum stacks | | | | | | | | | | Wells downgradient from former east overflow pond | | | | | Portneuf River area wells | | | | | Representative Concentrations | |
|------------------|------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---|-------|-----------|-------|-------|---------------------------|-----------|-------|-------|---------|-------------------------------|-------|
| | 300 | 306 | 313 | 315 | 316 | 325 | 326 | 332 | PEI-3 | PEI-5 | 310 | 317 | 320 | 319 | 327 | 305** | 321 | 322 | 328 | PEI-4** | PEI-6** | |
| | | | | | | | | | | | Deep Well | | Deep Well | | | Deep Well | Deep Well | | | | | |
| Arsenic | 0.557 | 0.217 | 0.244 | 0.221 | 0.365 | 0.102 | 0.473 | 0.208 | 0.302 | 0.086 | 0.411 | 0.370 | 0.080 | 0.020 | 0.030 | 0.010 | 0.006 | 0.004 | 0.002 | 0.002 | 0.004 | 0.032 |
| Boron | 0.536 | 0.484 | 0.490 | 0.511 | 0.602 | 0.377 | 0.622 | 0.544 | 0.734 | 0.208 | 3.406 | 0.606 | 0.421 | 0.100 | 0.170 | 0.084 | 0.111 | ND | 0.129 | 0.147 | 0.175 | 0.360 |
| Lithium | 0.037 | 0.110 | 0.198 | 0.177 | 0.344 | 0.142 | 0.355 | 0.248 | 0.222 | 0.427 | 0.546 | 0.253 | 0.133 | 0.042 | 0.058 | 0.009 | 0.039 | 0.024 | 0.034 | ND | 0.031 | 0.062 |
| Manganese | 0.005 | 0.001 | 0.060 | 0.003 | 0.018 | 0.078 | 0.009 | 0.041 | 0.042 | 0.990 | 8.651 | 0.002 | 0.444 | 0.001 | 0.003 | 0.009 | 0.002 | 0.011 | 0.001 | 0.078 | 0.088 | 0.078 |
| Nickel | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.011 | 0.013 | 0.036 | ND | 0.232 | 2.950 | 0.011 | 0.099 | 0.011 | 0.013 | 0.011 | 0.011 | ND | 0.011 | ND | 0.011 | 0.010 |
| Selenium | 0.010 | 0.006 | 0.025 | 0.007 | 0.037 | 0.005 | 0.023 | 0.016 | 0.013 | 0.007 | 0.026 | 0.004 | 0.024 | 0.002 | 0.004 | 0.002 | 0.003 | 0.004 | 0.002 | 0.002 | 0.002 | 0.007 |

Parameters elevated in Well 318 only

| | | | | | | | | | | | | | | | | | | | | | | |
|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Beryllium | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | ND | 0.021 | 0.056 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | ND | 0.001 | 0.002 | 0.001 | 0.003 |
| Cadmium | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.006 | 0.000 | 0.005 | 0.182 | 0.001 | 0.009 | 0.001 | 0.003 | 0.001 | 0.001 | ND | 0.001 | 0.000 | 0.001 | 0.006 |
| Chromium | 0.002 | 0.001 | 0.003 | 0.001 | 0.002 | 0.002 | 0.001 | 0.001 | 0.005 | 0.005 | 0.762 | 0.001 | 0.001 | 0.005 | 0.001 | 0.002 | 0.002 | 0.001 | 0.001 | 0.002 | 0.007 | 0.012 |
| Cobalt | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.004 | ND | ND | 0.037 | 0.003 | ND | 0.003 | 0.003 | 0.003 | 0.003 | ND | 0.003 | ND | 0.003 | 0.033 |
| Copper | 0.006 | 0.005 | 0.005 | 0.005 | 0.010 | 0.004 | 0.006 | 0.004 | 0.017 | 0.007 | 0.003 | 0.005 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | ND | 0.004 | 0.005 | 0.006 | 0.022 |
| Iron | 0.069 | 0.069 | 0.102 | 0.044 | 0.054 | 0.196 | 0.069 | 0.069 | 0.350 | 0.320 | 0.220 | 0.079 | ND | 0.069 | 0.041 | 0.069 | 0.069 | 0.028 | 0.069 | 0.685 | 0.382 | 1.100 |
| Lead | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | ND | ND | 0.013 | 0.001 | 0.004 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.006 | 0.002 | 0.006 |
| Mercury | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | ND | ND | 0.001 | 0.001 | ND | 0.000 | 0.000 | 0.000 | 0.000 | ND | 0.000 | 0.002 | 0.000 | 0.001 |
| Molybdenum | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 | ND | ND | 0.105 | 0.014 | ND | 0.013 | 0.013 | 0.013 | 0.013 | 0.030 | 0.013 | ND | 0.013 | 0.070 |
| Silver | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.013 | ND | 0.004 | 0.004 | ND | 0.004 | 0.004 | 0.006 | 0.004 | ND | 0.004 | 0.002 | 0.004 | 0.006 |
| Thallium | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | ND | ND | 0.004 | 0.001 | ND | 0.001 | 0.001 | 0.001 | 0.001 | ND | 0.001 | ND | 0.001 | 0.040 |
| Vanadium | 0.003 | 0.004 | 0.006 | 0.007 | 0.005 | 0.008 | 0.012 | 0.002 | 0.020 | ND | 0.020 | 0.029 | 0.032 | 0.004 | 0.004 | 0.002 | 0.002 | ND | 0.002 | ND | 0.002 | 0.124 |
| Zinc | 0.008 | 0.006 | 0.013 | 0.002 | 0.002 | 0.015 | 0.002 | 0.012 | 0.104 | 0.078 | 0.055 | 0.002 | 0.057 | 0.006 | 0.029 | 0.005 | 0.009 | ND | 0.006 | ND | 0.060 | 0.397 |

Parameter related to silt buildup in wells

| | | | | | | | | | | | | | | | | | | | | | | |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|-------|-------|-------|-------|-------|-------|----|-------|-------|-------|-------|
| Aluminum | 0.077 | 0.023 | 0.037 | 0.035 | 0.080 | 0.141 | 0.023 | 0.023 | 0.185 | 7.855 | 448.84* | 0.032 | 0.100 | 0.027 | 0.023 | 0.023 | 0.023 | ND | 0.023 | 1.920 | 0.502 | 0.680 |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------|-------|-------|-------|-------|-------|-------|----|-------|-------|-------|-------|

Notes: Metals not reported on this table were detected at concentrations below representative levels or not detected.

* Aluminum in groundwater from Well 318 is probably a result of low-pH water leaching aluminum from soils, or from former east overflow pond releases.

** These wells reflect representative groundwater quality.

*** Values for Well 332 are not means; only one sample was available at the time this report was prepared.

Well locations are shown in Figure 4.4-6.

ND = Not detected.

Table 4.4-15
Mean Concentrations (mg/l) of Nutrients and Fluoride in Groundwater – Eastern Simplot Area

| Well Designation | <i>Wells in vicinity of gypsum stacks</i> | | | | | | | | | | Representative Concentrations |
|------------------|---|-------|-------|-------|-------|-------|--------|-------|--------|--------|-------------------------------|
| | 300 | 306 | 313 | 315 | 316 | 325 | 326 | 332 | PEI-3 | PEI-5 | |
| Ammonia | 0.50 | 0.50 | 6.10 | 0.35 | 0.50 | 2.00 | 0.50 | 0.50 | ND | 0.20 | 0.8 |
| Fluoride | 0.16 | 0.17 | 0.40 | 0.18 | 0.13 | 0.13 | 0.15 | 0.30 | 0.11 | 9.80 | 0.7 |
| Nitrate | 2.53 | 2.11 | 57.88 | 6.57 | 13.92 | 24.35 | 14.38 | 5.34 | 3.60 | 1.83 | 4.5 |
| Orthophosphate | 176.25 | 27.15 | 23.75 | 33.15 | 61.38 | 8.11 | 129.87 | 31.70 | 86.25 | 123.30 | 1.8 |
| Phosphorus | 173.00 | 26.05 | 21.98 | 33.30 | 55.58 | 7.71 | 100.87 | 36.40 | 106.60 | 147.25 | 3.1 |

| Well Designation | <i>Former east overflow pond wells</i> | | | | | Representative Concentrations |
|------------------|--|--------|-----------|------|------|-------------------------------|
| | 318 | 317 | 320 | 319 | 327 | |
| | Deep Well | | Deep Well | | | |
| Ammonia | 23.90 | 0.50 | 13.87 | 0.50 | 0.50 | 0.8 |
| Fluoride | 1317 | 0.16 | 5.16 | 1.47 | 1.10 | 0.7 |
| Nitrate | 0.66 | 1.07 | 66.70 | 0.96 | 2.45 | 4.5 |
| Orthophosphate | 2880 | 103.83 | 37.37 | 0.08 | 6.20 | 1.8 |
| Phosphorus | 2390 | 98.0 | 34.20 | 0.06 | 6.30 | 3.1 |

| Well Designation | <i>Portneuf River Area Wells</i> | | | | | | Representative Concentrations |
|------------------|----------------------------------|------|-----------|------|-------|-------|-------------------------------|
| | 305 | 321 | 322 | 328 | PEI-4 | PEI-6 | |
| | Deep Well | | Deep Well | | | | |
| Ammonia | 0.50 | 0.50 | | 0.50 | | 0.50 | 0.8 |
| Fluoride | 0.49 | 0.15 | 0.20 | 0.23 | 0.20 | 0.20 | 0.7 |
| Nitrate | 0.94 | 2.81 | 40.26 | 2.19 | 1.76 | 1.64 | 4.5 |
| Orthophosphate | 0.05 | 0.03 | 0.02 | 0.03 | 0.09 | 0.09 | 1.8 |
| Phosphorus | 0.02 | 0.03 | 0.02 | 0.05 | 0.11 | 0.08 | 3.1 |

Notes: Wells 305, PEI-4, and PEI-6 are included in the representative well network.

Values for Well 332 are not means, one data point was available at the time this report was written.

Well locations are shown in Figure 4.4-6.

Table 4.4-16
Mean Values and Ranges of Physical Parameters and Major Ions in Groundwater – Eastern Simplot Area

| Well Designation | Wells in vicinity of gypsum stacks | | | | | | | | | | Representative Levels |
|--------------------------------------|------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|--------|-------------|-------------|-----------------------|
| | 300 | 306 | 313 | 315 | 316 | 325 | 326 | 332* | PEI-3 | PEI-5 | |
| pH | 5.70 - 5.81 | 6.21 - 6.43 | 6.19 - 6.30 | 6.23 - 6.34 | 6.16 - 6.27 | 6.33 - 6.46 | 6.16 - 6.34 | 6.15 | 6.01 - 7.70 | 4.65 - 7.60 | 6.9 - 8.9 |
| Mean specific conductance (µmhos/cm) | 4918 | 3747 | 4541 | 4277 | 5015 | 3391 | 5331 | 4880 | 4611 | 2730 | 1052 |
| Mean total dissolved solids (mg/l) | 4555 | 3832 | 4055 | 3787 | 4705 | 2895 | 4155 | 4340 | 4375 | 2965 | 746 |
| Temperature range (degrees Celcius) | 16.2 - 17.3 | 17.9 - 18.3 | 16.0 - 16.9 | 18.0 - 18.5 | 16.2 - 17.3 | 17.2 - 18.2 | 16.2 - 17.0 | 16.2 | 16.1 - 16.9 | 13.3 - 18.9 | 11.4 - 17.9 |
| Redox (millivolts) | 86 | 80 | 99 | 110 | 86 | 95 | 91 | | NM | NM | -38 to 255 |
| Alkalinity (bicarbonate) | 423.3 | 1275.8 | 859.0 | 1191.8 | 1235.8 | 721.3 | 1292.3 | 1050.0 | 751.5 | 73.3 | 315.0 |
| Calcium | 413.2 | 572.0 | 549.9 | 487.5 | 473.4 | 431.0 | 444.7 | 500.8 | 293.5 | 178.3 | 105.0 |
| Chloride | 96.0 | 117.1 | 165.3 | 121.5 | 115.3 | 117.8 | 121.3 | 137.0 | 118.5 | 92.9 | 177.0 |
| Magnesium | 87.1 | 180.2 | 173.4 | 208.3 | 269.5 | 125.1 | 299.7 | 208.2 | 146.6 | 120.2 | 42.0 |
| Potassium | 14.8 | 30.7 | 39.7 | 28.5 | 31.5 | 32.7 | 23.8 | 36.8 | 11.4 | 5.9 | 13.0 |
| Sodium | 685.0 | 304.5 | 297.3 | 324.0 | 468.4 | 241.2 | 581.4 | 456.4 | 425.5 | 226.5 | 64.0 |
| Sulfate | 2437.5 | 1972.5 | 1735.0 | 1607.5 | 2122.5 | 1228.3 | 2363.3 | 2330.0 | 2365.0 | 1514.5 | 79.0 |

| Wells downgradient from former east overflow pond | | | | | Portneuf River area wells | | | | | Representative Levels | | |
|---|-------------|-------------|-------------|-------------|---------------------------|-------------|--------------|-------------|--------------|-----------------------|-------------|--|
| | 317 | 320 | 319 | 321 | 305** | 321 | 322 | 328 | PEI-4** | PEI-6** | | |
| | Deep Well | | Deep Well | | | Deep Well | Deep Well | | | | | |
| pH | 5.86 - 6.14 | 5.64 - 6.38 | 7.40 - 7.74 | 6.44 - 6.69 | 7.32 - 7.42 | 7.24 - 7.38 | 7.25 - 9.40 | 7.03 - 7.26 | 7.04 - 8.80 | 7.08 - 8.90 | 6.9 - 8.9 | |
| Mean specific conductance (µmhos/cm) | 4595 | 3153 | 527 | 1359 | 486 | 788 | 918 | 854 | 817 | 816 | 1052 | |
| Mean total dissolved solids (mg/l) | 4143 | 2080 | 345 | 880 | 363 | 453 | 446 | 500 | 520 | 563 | 746 | |
| Temperature range (degrees Celcius) | 16.4 - 16.8 | 18.4 - 21.8 | 14.5 - 14.8 | 13.6 - 14.3 | 16.2 - 16.5 | 13.0 - 13.3 | 13.3 - 16.94 | 12.9 - 13.5 | 12.4 - 15.17 | 12.9 - 15.56 | 11.4 - 17.9 | |
| Redox (millivolts) | 80 | 155 | 130 | 158 | 65 | 101 | | 74 | 87 | 104 | -38 to 255 | |
| Alkalinity (bicarbonate) | 1247.3 | 476.7 | 161.8 | 348.3 | 134.3 | 263.0 | 275.5 | 292.7 | 292.8 | 287.4 | 315.0 | |
| Calcium | 367.2 | 301.6 | 46.0 | 133.5 | 51.4 | 72.6 | 60.0 | 86.6 | 73.6 | 74.5 | 105.0 | |
| Chloride | 114.0 | 98.0 | 26.6 | 69.0 | 46.0 | 59.9 | 53.0 | 55.5 | 62.7 | 62.9 | 177.0 | |
| Magnesium | 217.8 | 103.2 | 14.4 | 48.8 | 12.1 | 29.9 | 27.8 | 32.0 | 31.6 | 30.7 | 42.0 | |
| Potassium | 19.7 | 26.9 | 4.7 | 11.5 | 5.4 | 6.1 | 6.4 | 6.3 | 6.0 | 6.3 | 13.0 | |
| Sodium | 524.4 | 225.6 | 34.2 | 83.7 | 16.8 | 32.4 | 25.6 | 40.9 | 36.2 | 37.5 | 64.0 | |
| Sulfate | 1847.5 | 939.0 | 52.8 | 283.0 | 33.5 | 48.6 | 45.5 | 47.0 | 52.1 | 53.7 | 79.0 | |

Notes: * Values for Well 332 are not means; only one sample was available at the time this report was prepared.

** These wells reflect representative groundwater quality.

Well locations are shown in Figure 4.4-6.

Table 4.4-17
Activities of Radiological Parameters in Groundwater - Eastern Simplot Area

| | | Wells in vicinity of gypsum stacks | | | | | | | | | |
|-------------|----------------|------------------------------------|------------|-------------|-------------|-------------|------------|------------|-------------|-------------|------------|
| Parameter | Sampling Event | 300 | 306 | 313 | 315 | 318 | 325 | 328 | 332 | PEI-3 | PEI-5 |
| Gross alpha | Jun-92 | ND | ND | 8.3 ±6.60 | ND | ND | | | | ND | ND |
| | Sep-92 | ND | 27.3 ±3.39 | 11.7 ±2.50 | 20.8 ±1.89 | 17.6 ±3.08 | | | | ND | 7.97 ±0.03 |
| | Dec-92 | ND | 46.5 ±8.65 | 20.9 ±4.76 | 30.4 ±8.18 | ND | 8.69 ±4.97 | ND | | | |
| | Mar-93 | ND | 43.3 ±9.50 | 25.6 ±7.37 | 25.1 ±8.51 | 9.23 ±6.63 | 16.3 ±5.63 | 8.18 ±6.43 | | | |
| | Jul-93 | ND | 52.7 ±8.80 | 7.35 ±3.73 | 12.8 ±5.60 | ND | 5.08 ±2.91 | 5.33 ±3.44 | ND | | |
| Mean | | | | | | | | | | | |
| Gross beta | Jun-92 | 28.4 ±4.4 | 27.5 ±4.2 | 32.5 ±4.40 | 25.1 ±10.2 | 28.7 ±19.40 | | | | 14.70 ±3.20 | ND |
| | Sep-92 | 11.1 ±2.57 | 38 ±1.88 | 31 ±1.90 | 25.7 ±2.07 | 50.7 ±2.04 | | | | ND | 11.7 ±1.8 |
| | Dec-92 | 9.91 ±5.90 | 33.4 ±4.75 | 36.2 ±6.83 | 31.7 ±5.14 | 18.9 ±5.74 | 26 ±5.89 | 26.8 ±6.04 | | | |
| | Mar-93 | 42 ±9.92 | 38.1 ±7.80 | 27.4 ±10.90 | 49.5 ±11.00 | 30.3 ±9.47 | 36.2 ±8.75 | 33.2 ±8.74 | | | |
| | Jul-93 | ND | 45.7 ±8.40 | 35.6 ±4.57 | 49.7 ±8.40 | 12.2 ±7.20 | 20.1 ±4.59 | 14 ±7.14 | 27.10 ±4.34 | | |
| Mean | | | | | | | | | | | |
| Radium-226 | Sep-92 | ND | ND | ND | ND | ND | | | | | |
| | Dec-92 | ND | ND | ND | ND | ND | 1.53 ±0.20 | ND | | ND | ND |
| | Mar-93 | ND | ND | ND | ND | ND | ND | ND | | | |
| | Jul-93 | ND | ND | ND | ND | ND | ND | ND | ND | | |
| | Mean | | | | | | | | | | |
| Radium-228 | Sep-92 | ND | ND | ND | ND | ND | | | | | |
| | Dec-92 | ND | ND | 1.7 ±1.00 | ND | ND | 1.3 ±0.9 | ND | | ND | ND |
| | Mar-93 | 1.1 ±1.00 | 3.1 ±1.20 | ND | 1.6 ±0.80 | 6 ±1.30 | ND | ND | | | |
| | Jul-93 | ND | ND | ND | ND | ND | ND | ND | ND | | |
| | Mean | | | | | | | | | | |

Notes: ND = Not Detected

Means were not calculated if only ND was reported or if only positive value has been reported.

Blanks = no analyses performed

* Wells in representative network

Well locations are shown in Figure 4.4-6.

| | | Wells near Portneut River | | | | | |
|-------------|----------------|---------------------------|------------|------------|------------|------------|------------|
| Parameter | Sampling Event | 305* | 321 | 322 | 328 | PEI-4* | PEI-8* |
| Gross alpha | Jun-92 | ND | ND | ND | | ND | 4.6 ±2.30 |
| | Sep-92 | 3.08 ±0.45 | ND | 2.27 ±0.37 | | ND | 3.39 ±0.35 |
| | Dec-92 | 2.98 ±1.02 | 2.09 ±0.97 | | ND | 2.34 ±1.56 | 2.31 ±0.59 |
| | Mar-93 | 3.93 ±1.37 | 2.97 ±1.33 | | 3.27 ±1.11 | 2.49 ±1.08 | 3.56 ±1.48 |
| | Jul-93 | 2.3 ±0.70 | ND | | ND | | ND |
| Mean | | | | | | | |
| Gross beta | Jun-92 | ND | ND | 7.2 ±3.10 | | 12 ±3.00 | 9.1 ±2.9 |
| | Sep-92 | 6.89 ±0.52 | 5.42 ±0.35 | 6.35 ±0.49 | | 6.54 ±0.39 | 4.44 ±0.46 |
| | Dec-92 | 5.57 ±0.95 | 5.62 ±0.91 | | 4.62 ±1.0 | 10.1 ±1.1 | 4.04 ±0.56 |
| | Mar-93 | 6.67 ±1.23 | ND | | 6.79 ±1.37 | 21 ±1.95 | ND |
| | Jul-93 | 9.3 ±1.10 | 4.39 ±0.86 | | 4.09 ±0.81 | | 4.1 ±0.80 |
| Mean | | | | | | | |
| Radium-226 | Sep-92 | ND | ND | | ND | ND | ND |
| | Dec-92 | ND | ND | ND | ND | ND | ND |
| | Mar-93 | 3.41 ±0 | ND | | ND | ND | ND |
| | Jul-93 | ND | ND | | ND | | ND |
| | Mean | | | | | | |
| Radium-228 | Sep-92 | ND | 2.7 ±1.10 | | ND | 1.3 ±1 | ND |
| | Dec-92 | ND | ND | ND | ND | ND | ND |
| | Mar-93 | 2 ±1.00 | ND | | ND | 1.7 ±0.70 | 5.4 ±1.0 |
| | Jul-93 | ND | ND | | ND | | 5.3 ±0.80 |
| | Mean | | | | | | |

Wells downgradient from former east overflow pond

| Parameter | Sampling Event | 318 | 317 | 320 | 319 | 327 |
|-------------|----------------|-------------|-------------|------------|------------|------------|
| Gross alpha | Jun-92 | ND | ND | ND | ND | |
| | Sep-92 | 984.4 ±23.7 | ND | 8.36 ±1.28 | 2.18 ±0.46 | |
| | Dec-92 | 1340 ±65.7 | | 3.94 ±3.22 | 3.29 ±1.23 | 2.65 ±1.80 |
| | Mar-93 | 1690 ±106 | 5.17 ±0.56 | ND | 2.45 ±1.00 | ND |
| | Jul-93 | 648 ±44.8 | ND | ND | ND | ND |
| Mean | | | | | | |
| Gross beta | Jun-92 | 33.8 ±4.30 | 11.1 ±3.30 | 7.1 ±3.7 | ND | |
| | Sep-92 | 1163.19 ±19 | 17.59 ±2.04 | 28.5 ±1.5 | 5.15 ±0.46 | |
| | Dec-92 | 994 ±38.9 | | 26.4 ±3.53 | 5.76 ±1 | 11.3 ±1.27 |
| | Mar-93 | 605 ±35 | 19.7 ±6.08 | 33.2 ±7.15 | ND | 11.1 ±1.59 |
| | Jul-93 | 397 ±29.8 | 11.6 ±5.3 | 38.2 ±7.7 | 5.4 ±0.80 | 6.43 ±1.04 |
| Mean | | | | | | |
| Radium-226 | Sep-92 | ND | ND | ND | ND | ND |
| | Dec-92 | ND | ND | ND | ND | ND |
| | Mar-93 | ND | ND | ND | ND | ND |
| | Jul-93 | ND | ND | ND | ND | ND |
| | Mean | | | | | |
| Radium-228 | Sep-92 | 7 ±1 | ND | ND | ND | ND |
| | Dec-92 | 7.8 ±1.1 | | ND | ND | ND |
| | Mar-93 | ND | ND | ND | ND | ND |
| | Jul-93 | ND | ND | ND | 4.7 ±0.80 | ND |
| | Mean | | | | | |

Table 4.4-18
Organic Compounds Detected in Groundwater at Simplot

| Parameter | Sampling Event | Representative Wells/Unimpacted Areas | | | | 310 | 312 | 300 | Wells 304 | 307 | 316 | PEI-5 | 320 | 318 | Practical Quantitation Limits (mg/l) |
|--------------------------------|----------------|---------------------------------------|-------|-------|-------|-------|-------|-------|-----------|-------|-------|-------|-------|-------|--------------------------------------|
| | | 301 | PEI-1 | PEI-6 | PEI-4 | | | | | | | | | | |
| VOLATILE ORGANIC COMPOUNDS | | | | | | | | | | | | | | | |
| 2-Butanone | Jun-92 | 0.003 | | | | | | | | | | | | | 0.1 |
| 2-Butanone | Dec-92 | | | | | | | | | | | | | 0.01 | |
| Acetone | Jun-92 | 0.361 | 0.524 | | 0.217 | | 0.394 | | | | 0.22 | 1.85 | | | 0.005 |
| Acetone | Sep-92 | 0.12 | | | 0.073 | 0.026 | | 0.12 | 0.43 | 0.017 | 0.21 | | | 0.032 | |
| Acetone | Dec-92 | | | | | | | | | | | | | 0.061 | 0.005 |
| Ethyl benzene | Jun-92 | 0.001 | | | | | | | | | | | | | 0.005 |
| Methylene chloride | Jun-92 | | | | | | | | | | | 0.001 | | 0.004 | 0.005 |
| Tetrachloroethene | Jun-92 | | | | | | | | | | 0.001 | | | | 0.005 |
| 1,1,1-Trichloroethane | Sep-92 | | | | 0.009 | | | | | | | | | | 0.005 |
| 1,1,1-Trichloroethane | Dec-92 | | | | | | 0.008 | | | | | | | | |
| Trichloroethene | Jun-92 | | | 0.005 | | | | | | 0.028 | | | | | 0.005 |
| Xylenes, total | Jun-92 | 0.008 | 0.006 | | | | | | | | | | | | |
| SEMIVOLATILE ORGANIC COMPOUNDS | | | | | | | | | | | | | | | |
| Benzoic acid | Sep-92 | | | | | | | | | | | | | 0.003 | 0.01 |
| Benzoic acid | Dec-92 | | | | | | | | | | | | | 0.001 | |
| Bis(2-ethylhexyl)phthalate | Jun-92 | | | 0.001 | | | 0.005 | | | | 0.003 | | | | 0.01 |
| Bis(2-ethylhexyl)phthalate | Sep-92 | 0.026 | | 0.013 | | | | 0.016 | | | | | | | |
| Bis(2-ethylhexyl)phthalate | Dec-92 | 0.054 | | 0.025 | | | | 0.026 | 0.023 | | 0.017 | | 0.006 | | 0.01 |
| Di-n-butyl phthalate | Jun-92 | | | | | | | | | | 0.001 | | | | 0.01 |
| Di-n-butyl phthalate | Dec-92 | 0.001 | | | | | | | | | | | | | |
| Di-n-octyl phthalate | Sep-92 | | | | | | 0.001 | | | | | | | | 0.01 |
| Diethyl phthalate | Sep-92 | | | | | | | | | | 0.001 | | | | |
| Dimethyl phthalate | Jun-92 | | | | | | | | | | 0.001 | | | | 0.01 |
| | | | | | | | | | | | | | | | |
| PCBS AND FURANS | | | | | | | | | | | | | | | |
| Tetrahydrofuran | Dec-92 | | | | | | 0.292 | | | | | | | | |

Well locations are shown in Figure 4.4-6.

Table 4.4-19
Mean Concentrations (mg/l) of Metals in Groundwater – Joint Fenceline Area

WELL
DESIGNATION

Wells downgradient from Simplot gypsum stack and FMC potential sources

| | 105 | 110 | 115 | 141 | 145 | 123 | 329 | 330 | Representative Concentrations (upper limit) |
|-----------|-----------|--------|--------|-----------|--------|-----------|-----------|--------|---|
| | Deep Well | | | Deep Well | | Deep Well | Deep Well | | |
| Aluminum | ND | ND | ND | 0.7000 | 0.9100 | 0.5800 | 0.0365 | 0.0379 | 0.68 |
| Arsenic | 0.0050 | 0.1180 | 0.5288 | 0.4481 | 0.0275 | 0.3031 | 0.5519 | 0.0072 | 0.032 |
| Boron | 0.2677 | 0.7943 | 0.6655 | 1.1908 | 0.4328 | 0.7820 | 0.9994 | 0.1281 | 0.36 |
| Cadmium | ND | 0.0006 | 0.0030 | 0.0064 | 0.0010 | 0.0010 | 0.0003 | 0.0010 | 0.006 |
| Copper | ND | 0.0116 | 0.0163 | 0.0122 | 0.0050 | 0.0253 | 0.0161 | 0.0040 | 0.022 |
| Lithium | 0.0481 | 0.1407 | 0.5029 | 0.2594 | 0.0899 | 0.4786 | 0.2495 | 0.0643 | 0.062 |
| Manganese | ND | 0.1427 | 2.1895 | 0.7323 | 0.2152 | 1.0629 | 0.4500 | 0.0081 | 0.078 |
| Nickel | ND | ND | 0.0344 | 0.0673 | ND | 0.0239 | 0.0117 | 0.0116 | 0.01 |
| Selenium | 0.0020 | 0.0503 | 0.0606 | 0.1486 | 0.0171 | 0.1279 | 0.3426 | 0.0020 | 0.007 |
| Vanadium | ND | 0.0161 | 0.0218 | 0.1368 | 0.0400 | 0.0307 | 0.1876 | 0.0020 | 0.124 |
| Zinc | ND | ND | 0.0440 | 0.0087 | 0.0181 | ND | ND | 0.0130 | 0.397 |

WELL
DESIGNATION

Wells downgradient from Simplot gypsum stack only

| | 304 | 307 | 308 | 309 | 310 | 312 | 324 | 331 | 332 | 142 |
|-----------|-----------|--------|--------|--------|-----------|--------|--------|--------|--------|--|
| | Deep Well | | | | Deep Well | | | | | West of gypsum stack upgradient of former calciner ponds |
| Aluminum | 0.0230 | 0.0465 | 0.0530 | 0.2151 | 0.0230 | 0.0725 | 0.7137 | 0.0230 | 0.0230 | 0.2240 |
| Arsenic | 0.0038 | 0.6244 | 0.4860 | 0.0841 | 0.1437 | 0.2204 | 0.5760 | 0.0139 | 0.2377 | 0.0025 |
| Boron | 0.1103 | 0.7497 | 0.6894 | 0.4830 | 0.5135 | 0.8320 | 0.5872 | 0.1472 | 0.5305 | 0.7224 |
| Cadmium | 0.0010 | 0.0039 | 0.0157 | 0.0010 | 0.0010 | 0.0007 | 0.0010 | 0.0010 | 0.0010 | 0.0010 |
| Copper | 0.0040 | 0.0057 | 0.0042 | 0.0040 | 0.0040 | 0.0136 | 0.0067 | 0.0047 | 0.0040 | 0.0143 |
| Lithium | 0.0225 | 0.6162 | 0.5119 | 0.1949 | 0.1691 | 0.2555 | 0.1853 | 0.0512 | 0.2270 | 0.4282 |
| Manganese | 0.0040 | 0.1019 | 0.5419 | 0.0049 | 0.0110 | 0.6928 | 0.0407 | 0.0104 | 0.0995 | 0.0243 |
| Nickel | 0.0110 | 0.0110 | 0.0736 | 0.0110 | 0.0156 | 0.0553 | 0.0110 | 0.0110 | 0.0110 | ND |
| Selenium | 0.0092 | 0.0095 | 0.0194 | 0.0049 | 0.0129 | 0.2142 | 0.0039 | 0.0017 | 0.0653 | 0.0090 |
| Vanadium | 0.0020 | 0.0296 | 0.0218 | 0.0055 | 0.0289 | 0.0360 | 0.0033 | 0.0031 | 0.0058 | 0.0142 |
| Zinc | 0.0080 | 0.0020 | 0.0275 | 0.0075 | 0.0165 | 0.0088 | 0.0079 | 0.0128 | 0.0065 | 0.0070 |

| Representative Concentrations (upper limit) |
|---|
| 0.68 |
| 0.032 |
| 0.36 |
| 0.006 |
| 0.022 |
| 0.062 |
| 0.078 |
| 0.01 |
| 0.007 |
| 0.124 |
| 0.397 |

WELL
DESIGNATION

*Wells upgradient from Simplot gypsum stack ****

| | 105 | 110 | Representative Concentrations (upper limit) |
|-----------|--------|--------|---|
| Aluminum | 0.0950 | 0.1804 | 0.68 |
| Arsenic | 0.0073 | 0.0068 | 0.032 |
| Boron | 0.1850 | 0.0419 | 0.36 |
| Cadmium | ND | 0.0006 | 0.006 |
| Copper | ND | 0.0040 | 0.022 |
| Lithium | 0.0055 | 0.0073 | 0.062 |
| Manganese | 0.0070 | 0.0062 | 0.078 |
| Nickel | ND | 0.0110 | 0.01 |
| Selenium | 0.0053 | 0.0020 | 0.007 |
| Vanadium | ND | 0.0038 | 0.124 |
| Zinc | 0.0180 | 0.0266 | 0.397 |

Notes: ND = Not detected.

Concentrations reported in this table are mean concentrations calculated from up to five quarterly sampling events, expressed in mg/L. Well locations are shown in Figure 4.4-6.

* Arsenic concentrations were significantly below means in these wells for August 1993 sampling event.

**Classification of wells 312, 324, and 331 as being downgradient of FMC potential sources subject to further evaluation.

***Representative wells.

Table 4.4-20
Mean Nutrient and Fluoride Concentrations (mg/l) in Groundwater – Joint Fenceline Area

| WELL | Wells downgradient from Simplot gypsum stack and FMC potential sources | | | | | | | | | Representative Concentrations (upper limit) |
|-------------------|--|-------|--------|-------|--------------|-------|-------|--------------|--------------|---|
| DESIGNATION | 105 | 110 | 116 | 118 | 119 | 115 | 122 | 123 | 130 | |
| | Deep Well | | | | Deep Well | | | Deep Well | Deep Well | |
| Ammonia | ND | ND | 10.50 | 6.94 | 0.50 | 12.08 | 4.38 | 0.50 | 0.50 | 0.8 |
| Fluoride | 0.89 | 0.26 | 1.50 | 0.39 | 0.41 | 0.81 | 0.67 | 0.80 | 0.20 | 0.7 |
| Nitrate | 0.93 | 3.84 | 2.65 | 7.35 | 3.98 | 3.06 | 10.83 | 0.87 | 0.78 | 4.5 |
| Orthophosphate | 0.02 | 4.81 | 113.00 | 13.16 | 0.44 | 86.06 | 4.86 | 0.02 | 0.02 | 1.8 |
| Phosphorus, total | 0.02 | 16.24 | 114.00 | 14.20 | 1.24 | 90.28 | 5.12 | 0.02 | 0.02 | 3.1 |

| WELL DESIGNATION | Wells downgradient from Simplot gypsum stack only | | | | | | | | | | | Representative Concentrations (upper limit) |
|---------------------|---|--------|--------|-------|-------|-------|--------|------|-------|-------|---|---|
| | 301 | 307 | 308 | 310 | 312 | 322 | 323 | 324 | 331 | 333 | 142 | |
| | Deep Well | | | | | | | | | | West of gypsum stack upgradient of former calciner ponds | |
| Ammonia | 0.50 | 1.28 | 35.95 | 0.50 | 0.50 | 3.00 | 0.50 | 0.50 | 0.80 | 0.50 | ND | 0.8 |
| Fluoride | 0.17 | 0.18 | 1.36 | 0.51 | 0.21 | 0.20 | 1.05 | 0.73 | 0.20 | 0.20 | 0.1405 | 0.7 |
| Nitrate | 5.54 | 2.30 | 31.07 | 2.50 | 2.37 | 29.20 | 2.25 | 0.89 | 4.46 | 2.80 | 2.0720 | 4.5 |
| Orthophosphate | 27.51 | 166.75 | 134.96 | 11.14 | 26.03 | 21.00 | 164.00 | 0.21 | 29.92 | 91.50 | 0.0463 | 1.8 |
| Phosphorus, total | 19.18 | 163.00 | 126.08 | 14.46 | 31.45 | 26.30 | 128.33 | 0.23 | 28.94 | 87.80 | 0.0400 | 3.1 |

| WELL DESIGNATION | Wells upgradient from Simplot gypsum stack * | | | Representative Concentrations (upper limit) |
|---------------------|--|------|--|---|
| | 123-5 | 301 | | |
| Ammonia | ND | 0.50 | | 0.8 |
| Fluoride | 0.36 | 0.58 | | 0.7 |
| Nitrate | 0.65 | 0.75 | | 4.5 |
| Orthophosphate | 0.24 | 0.03 | | 1.8 |
| Phosphorus, total | 0.02 | 0.03 | | 3.1 |

Notes: ND = Not detected.

Concentrations reported in this table are mean concentrations calculated from up to five quarterly sampling events, expressed in mg/l.

Well locations are shown in Figure 4.4-6.

* Representative wells.

** Wells 312, 324, and 331 as being downgradient of FMC potential sources subject to further evaluation.

Table 4.4-21
Means and Ranges of Physical Parameters and Major Ions in Groundwater - Joint Fenceline Area

| WELL DESIGNATION | Wells downgradient from Simplot gypsum stack and FMC potential sources | | | | | | | | | | Representative Levels |
|--------------------------------------|--|-------------|-------------|-------------|-------------|-------------|-------------|-------|-------|--|--------------------------|
| | 109 | 110 | 113 | 143 | 144 | 145 | 123 | 329 | 330 | | |
| | Deep Well | | | | | Deep Well | | | | | |
| pH | 7.39 - 7.53 | 6.36 - 6.45 | 6.05 - 6.13 | 6.16 - 6.29 | 6.68 - 7.24 | 6.08 - 6.55 | 5.95 - 6.26 | 7.47 | 7.48 | | 6.9 - 8.9 |
| Mean specific conductance (umhos/cm) | 551 | 2382 | 4982 | 3086 | 1709 | 4277 | 3647 | 564 | 521 | | 1052 |
| Mean total dissolved solids (mg/l) | 358 | 1783 | 4170 | 2918 | 1292 | 4044 | 2856 | 350 | 350 | | 746 |
| Temperature Range (degrees Celsius) | 14.9 - 15.6 | 15.9 - 16.6 | 14.4 - 15.4 | 15.8 - 16.6 | 14.3 - 16.9 | 14.3 - 14.9 | 17.0 - 17.5 | 16.2 | 14.8 | | 11.4 - 17.9 |
| Redox (millivolts)* | 141 | 190 | 130 | 69 | 442 | 312 | -3 | 60 | 80 | | -38 to 255 |
| Alkalinity (bicarbonate) | 161.0 | 556.8 | 1155.0 | 780.2 | 396.4 | 1135.4 | 692.0 | 156.0 | 158.0 | | 315.0 |
| Calcium | 53.9 | 213.4 | 313.4 | 409.4 | 218.2 | 387.4 | 339.0 | 54.9 | 50.2 | | 105.0 |
| Chloride | 35.8 | 133.2 | 151.0 | 305.8 | 149.2 | 162.4 | 364.0 | 29.0 | 26.0 | | 177.0 |
| Magnesium | 15.9 | 87.9 | 290.7 | 168.0 | 72.1 | 209.3 | 157.0 | 16.0 | 15.8 | | 42.0 |
| Potassium | 5.8 | 17.0 | 122.1 | 37.7 | 16.6 | 85.3 | 30.0 | 6.3 | 5.2 | | 13.0 |
| Sodium | 35.3 | 165.4 | 695.7 | 409.9 | 86.6 | 607.1 | 249.0 | 36.8 | 34.6 | | 64.0 |
| Sulfate | 57.5 | 627.9 | 1784.8 | 996.6 | 407.4 | 1711.4 | 924.0 | 55.0 | 47.0 | | 79.0 |

| WELL DESIGNATION | Wells downgradient from Simplot gypsum stack only | | | | | | | | | | Representative Levels |
|--------------------------------------|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------|--------|--------------------------|
| | 304 | 307 | 308 | 309 | 310 | 312 | 322 | 324 | 331 | 333 | |
| | Deep Well | | | | | | | | | | |
| pH | 6.71 - 6.82 | 6.07 - 6.24 | 6.06 - 6.13 | 6.27 - 6.41 | 6.33 - 6.46 | 6.17 - 6.29 | 5.82 - 5.98 | 7.10 - 7.28 | 6.30 | 6.08 | 6.43 - 6.68 |
| Mean specific conductance (umhos/cm) | 2726 | 5102 | 4700 | 3188 | 3297 | 3771 | 3558 | 756 | 3210 | 4700 | 2558 |
| Mean total dissolved solids (mg/l) | 2240 | 4410 | 4322 | 2767 | 2574 | 3017 | 3627 | 460 | 2380 | 4080 | 2682 |
| Temperature Range (degrees Celsius) | 16.3 - 16.8 | 16.0 - 16.6 | 15.5 - 15.8 | 19.2 - 19.8 | 19.4 - 20.1 | 15.6 - 18.7 | 16.6 - 17.1 | 16.9 - 17.6 | 17.7 | 16.1 | 19.06 - 14.9 |
| Redox (millivolts)* | 108 | 131 | 83 | 106 | 137 | 134 | 95 | 90 | 118 | 124 | 90 |
| Alkalinity (bicarbonate) | 653.5 | 1186.8 | 1075.8 | 807.3 | 721.8 | 836.8 | 557.7 | 213.0 | 650.0 | 1010.0 | 933.0 |
| Calcium | 419.0 | 206.8 | 246.9 | 365.5 | 311.0 | 333.5 | 434.5 | 74.7 | 284.3 | 311.1 | 398.0 |
| Chloride | 195.5 | 126.8 | 121.4 | 116.8 | 117.2 | 162.2 | 114.0 | 47.4 | 129.0 | 141.0 | 121.0 |
| Magnesium | 116.5 | 428.9 | 275.1 | 88.3 | 97.3 | 133.7 | 128.1 | 21.4 | 106.2 | 296.0 | 125.0 |
| Potassium | 16.7 | 32.4 | 35.9 | 50.5 | 25.2 | 22.9 | 27.0 | 6.6 | 17.8 | 32.0 | 18.0 |
| Sodium | 32.7 | 613.2 | 570.0 | 278.4 | 335.1 | 291.5 | 458.3 | 45.9 | 282.5 | 535.6 | 125.0 |
| Sulfate | 747.0 | 1905.0 | 1934.0 | 999.0 | 1265.7 | 1312.4 | 1810.0 | 119.0 | 1200.0 | 2270.0 | 1004.0 |

142
 Upgradient of former calcliner ponds
 West of gypsum stack

| Representative Levels |
|--------------------------|
| 6.9 - 8.9 |
| 1052 |
| 746 |
| 11.4 - 17.9 |
| -38 to 255 |
| 315.0 |
| 105.0 |
| 177.0 |
| 42.0 |
| 13.0 |
| 64.0 |
| 79.0 |

| WELL DESIGNATION | Wells upgradient from Simplot gypsum stack *** | | |
|--------------------------------------|--|-------------|--------------------------|
| | 125 | 60 | Representative Levels |
| pH | 6.72 - 6.82 | 6.09 - 6.24 | 6.9 - 8.9 |
| Mean specific conductance (umhos/cm) | 436 | 442 | 1052 |
| Mean total dissolved solids (mg/l) | 1745 | 310 | 746 |
| Temperature Range (degrees Celsius) | 15.8 - 17.1 | 13.3 - 15.1 | 11.4 - 17.9 |
| Redox (millivolts)* | | 61 | -38 to 255 |
| Alkalinity (bicarbonate) | 156.0 | 140.0 | 315.0 |
| Calcium | 53.1 | 46.2 | 105.0 |
| Chloride | 43.0 | 42.8 | 177.0 |
| Magnesium | 11.8 | 11.9 | 42.0 |
| Potassium | 5.9 | 6.0 | 13.0 |
| Sodium | 13.5 | 20.3 | 64.0 |
| Sulfate | 13.0 | 12.5 | 79.0 |

Notes: Values reported in this table are mean values calculated from up to five quarterly sampling events.

Well locations are shown in Figure 4.4-6.

* Redox values are one measurement only.

** Phase II wells have only one temperature and pH measurement; reporting ranges are not applicable.

*** Representative wells.

**** Wells 312, 324, and 331 as being downgradient of FMC potential sources subject to further evaluation.

Table 4.4-22
Activities of Radiological Parameters in Groundwater - Joint Fenceline Area

| Parameter | Sampling Event | 109 Deep Well | 123 | 110 | 136 | 143 | 144 Deep Well | 145 | 142 Upgradient of FMC Potential Sources | 301** | PEI-1** |
|-------------|----------------|------------------|------------|------------|------------|------------|------------------|-------------|--|------------|------------|
| Gross alpha | Jun-92 | 12.2 ±2.7 | ND | 34 ±7.7 | ND | ND | ND | 6.00 ±5.90 | 5.5 ±5.1 | ND | 2.4 ±1.30 |
| | Sep-92 | 5.12 ±1.21 | ND | 2.65 ±0.70 | 4.11 ±1.37 | 2.44 ±0.54 | 7.34 ±0.77 | 2.73 ±1.40 | 36.3 ±1.93 | 4.57 ±0.89 | 2.78 ±0.41 |
| | Dec-92 | 3.20 ±0.60 | 3.89 ±3.35 | 7.22 ±3.19 | 4.4 ±0.96 | 7.59 ±2.75 | 26.80 ±3.03 | ND | 49 ±6.11 | 2.66 ±0.55 | ND |
| | Mar-93 | 2.59 ±1.05 | ND | 3.63 ±3.27 | ND | 7.21 ±4.59 | 27.20 ±4.31 | 8.71 ±5.75 | 31.4 ±6.66 | 4.94 ±1.06 | ND |
| | Jul-93 | 2.27 ±0.57 | ND | ND | ND | ND | ND | ND | ND | 2.5 ±0.80 | ND |
| Gross beta | Jun-92 | 22.9 ±3.8 | 21.7 ±4.20 | 31.9 ±4.1 | 49.1 ±5.2 | 24.2 ±4.3 | 9.30 ±3.7 | 43.80 ±5.1 | 15.1 ±3.2 | ND | 11 ±3.70 |
| | Sep-92 | 6.36 ±1.23 | 29.8 ±2.13 | 21.8 ±1.10 | 85.7 ±2.76 | 17.9 ±1.72 | 22.40 ±0.92 | 77.40 ±3.20 | 23.7 ±1.28 | 6.29 ±0.82 | 7.95 ±0.49 |
| | Dec-92 | 5.9 ±0.71 | 34.4 ±6.33 | ND | 9.9 ±0.74 | ND | 22.20 ±1.74 | 65.70 ±6.97 | 29.9 ±3.37 | 5.87 ±0.7 | ND |
| | Mar-93 | 5.37 ±1.03 | 21.3 ±5.69 | 16.3 ±3.13 | 79.7 ±8.31 | 29.4 ±5.67 | 77.40 ±4.49 | 70.50 ±8.04 | 18.8 ±4.71 | ND | ND |
| | Jul-93 | 4.73 ±0.65 | ND | ND | ND | ND | ND | ND | ND | 10.8 ±1.10 | ND |
| Radium-226 | Jun-92 | ND | ND | ND | ND | 2.49 ±0.61 | 1.19 ±0.35 | 11.23 ±0.31 | 2.75 ±0.57 | 1.65 ±0.53 | ND |
| | Sep-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | Dec-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | Mar-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | Jul-93 | 3.83 ±0.50 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Radium-228 | Sep-92 | ND | ND | 6 ±1.3 | ND | ND | 12.90 ±1.30 | ND | 1.1 ±0.7 | 2.7 ±1.00 | ND |
| | Dec-92 | 3.0 ±1.0 | ND | ND | 2.8 ±1.1 | ND | ND | ND | ND | 1 ±0.60 | ND |
| | Mar-93 | ND | ND | ND | ND | ND | ND | ND | ND | 1 ±0.70 | ND |
| | Jul-93 | ND | ND | ND | ND | ND | ND | ND | ND | 1 ±0.60 | ND |
| | MEAN | | | | | | | | | | |

| Parameter | Sampling Event | 304 | 307 | 308 | 309 | 310 Deep Well | 312 | 323 | 324 | 329 Deep Well | 330 Deep Well | 331 | 333 |
|-------------|----------------|------------|------------|-------------|-------------|------------------|------------|------------|------------|------------------|------------------|------------|------------|
| Gross alpha | Jun-92 | ND | ND | ND | 8.8 ±5.70 | 8.35 ±4.7 | ND | ND | ND | ND | ND | ND | ND |
| | Sep-92 | 170 ±3.52 | 11 ±0.03 | ND | 17.49 ±2.30 | 13.5 ±1.54 | 8.63 ±1.95 | ND | 2.26 ±1.66 | ND | ND | ND | ND |
| | Dec-92 | 250 ±12 | ND | ND | 23.7 ±5.14 | 6.55 ±5.00 | ND | ND | ND | 2.01 ±1.05 | ND | 4.34 ±2.32 | ND |
| | Mar-93 | 182 ±14 | 3.67 ±10.9 | 11 ±7.32 | 21.9 ±7.08 | ND | ND | ND | ND | ND | ND | ND | ND |
| | Jul-93 | 166 ±12.9 | ND | ND | 23.9 ±4.15 | ND | 5.98 ±2.34 | ND | ND | ND | ND | ND | ND |
| Gross beta | Jun-92 | ND | ND | ND | ND | 16.95 ±3.50 | 15.8 ±3.30 | ND | ND | ND | ND | ND | ND |
| | Sep-92 | 92.4 ±1.69 | 16.4 ±2.98 | 35.76 ±2.60 | 43.86 ±1.97 | 10.7 ±1.79 | 30.4 ±1.67 | ND | ND | ND | ND | ND | ND |
| | Dec-92 | 57.6 ±3.35 | 58.7 ±5.47 | 24.7 ±4.67 | 30.8 ±3.92 | 19.6 ±5.8 | 28.5 ±6.1 | 21.9 ±5.10 | 8.12 ±1.42 | ND | ND | ND | ND |
| | Mar-93 | 59.1 ±7.01 | 17.4 ±9.31 | 54.7 ±12 | 44.5 ±6.61 | 19.2 ±6.45 | 16.8 ±8.67 | 17.9 ±8.94 | 5.75 ±1.47 | 4.55 ±1.17 | 3.36 ±0.81 | 9.59 ±4.04 | 19.5 ±4.51 |
| | Jul-93 | 78.3 ±8.6 | 30 ±6.0 | 41.1 ±7.90 | 33.3 ±4.73 | 9.27 ±2.45 | 18.4 ±4.53 | 26.2 ±7.50 | 4.73 ±0.92 | ND | ND | ND | ND |
| Radium-226 | Jun-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | Sep-92 | ND | ND | ND | ND | ND | ND | 3.63 ±0.32 | ND | ND | ND | ND | ND |
| | Dec-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | Mar-93 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | Jul-93 | 1.67 ±0.21 | 1.15 ±0.16 | ND | ND | ND | ND | ND | ND | 1.26 ±0.2 | ND | ND | ND |
| Radium-228 | Sep-92 | ND | ND | ND | ND | ND | 3 ±1.10 | ND | ND | ND | ND | ND | ND |
| | Dec-92 | 13.8 ±1.80 | ND | ND | 1 ±1.00 | ND | ND | 1.1 ±0.90 | ND | ND | ND | ND | ND |
| | Mar-93 | 1.9 ±0.70 | 4.1 ±1.0 | ND | ND | 6.1 ±0.90 | ND | 7.4 ±1.20 | ND | 1.00 ±0.7 | ND | ND | ND |
| | Jul-93 | ND | ND | 1.3 ±0.60 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| | MEAN | | | | | | | | | | | | |

Notes: ** These wells are part of representative groundwater network
Means were calculated only where two or more values were reported
Blanks = Not analyzed ND = Not Detected

Well locations are shown in Figure 4.4-6.

Table 4.4-23
Constituents Found At or Below Representative Levels in Groundwater from Offsite Wells

| Parameter | All Offsite Monitoring Wells | | | | | Representative Wells (16 Wells) | | | |
|--|---------------------------------|----------|----------|-----|--|------------------------------------|-------------|-----------|--|
| | Number of Samples Analyzed: 127 | | | | | Range | | | |
| | Mean | Range(a) | | NOS | | Mean | (2 S.D.)(b) | | |
| COMMON IONS (in mg/l) | | | | | | | | | |
| Alkalinity, carbonate | 0.0 | 0.0 | to 0.0 | 127 | | 1.2 | ND | to 5 | |
| METALS (in mg/l) | | | | | | | | | |
| <u>Metals Present in Groundwater in EMF Study Area within Representative Concentrations</u> | | | | | | | | | |
| Antimony | 0.05 | 0.05 | 0.06 | 34 | | 0.12 | 0.04 | to 0.20 | |
| Lead | 0.001 | 0.001 | 0.003 | 46 | | 0.002 | ND | to 0.006 | |
| Molybdenum | 0.02 | 0.01 | 0.07 | 45 | | 0.03 | ND | to 0.07 | |
| Silver | 0.004 | 0.002 | 0.004 | 36 | | 0.004 | 0.002 | to 0.006 | |
| <u>Metals Present in Groundwater in EMF Study Area Detected at Concentrations Occasionally above Representative Concentrations</u> | | | | | | | | | |
| Barium | 0.13 | 0.02 | 2.2 | 106 | | 0.12 | 0.02 | to 0.22 | |
| Mercury | 0.0003 | 0.0001 | 0.0020 | 54 | | 0.0006 | ND | to 0.0013 | |
| <u>Metals Present in Groundwater in Offsite Wells within Representative Concentrations</u> | | | | | | | | | |
| Beryllium | 0.001 | 0.001 | to 0.003 | 41 | | 0.002 | 0.0007 | to 0.003 | |
| Chromium | 0.001 | 0.001 | to 0.002 | 73 | | 0.005 | ND | to 0.012 | |
| Thallium | 0.001 | 0.001 | to 0.005 | 39 | | 0.040 | 0.040 | to 0.040 | |
| Zinc | 0.024 | 0.002 | to 0.126 | 60 | | 0.059 | ND | to 0.397 | |
| <u>Additional Metals Detected in Groundwater in Offsite Wells near Detection Limits or Representative Concentrations</u> | | | | | | | | | |
| Cadmium | 0.002 | 0.0004 | to 0.008 | 44 | | 0.003 | 0.001 | to 0.006 | |
| Nickel | 0.03 | 0.01 | to 0.09 | 37 | | 0.01 | 0.01 | to 0.01 | |
| ORGANIC COMPOUNDS | | | | | | | | | |
| Generally not detected (See Table 4.4-27 for details) | | | | | | | | | |

(a) Min = Minimum detected value, Max = Maximum, NOS = Number of Samples in which parameter detected.

(b) S.D. = Standard Deviation. Range is mean \pm two times Standard Deviation

ND = Results for all samples below detection limit.

Table 4.4-24
Metals Concentrations in Offsite Groundwater

| Parameter (mg/l) | | UNIMPACTED WELLS | | | | | | | | | | | | | | | IMPACTED WATER | | | | | REPRESENTATIVE CONCENTRATIONS (2 S.D.) (a) |
|--|------------------------------------|--|----------------|---------|--------------------------|-----------------|---|---------|----------------------|-------------|-------------|---|----------------------|--------------|-------------|---------|--|------|-----|--|--|--|
| | | Portneuf River Regime Representative Wells 510, 511, 512, 513 and Wells 506, 507, 508, 520 | | | | | Bannock Range Regime Representative Well Idaho Power and Wells 500, 502, 504, 508, 514, 516, 518, NPH, Rowlands, Tank Farm, TW-111, TW-11S | | | | | Michaud Flats Regime Wells 501, 515, and Lindley | | | | | Wells 503, 505, 517, 518, TW-9S, TW-12S, Frontier, Old Pilot House, and Batiste Spring | | | | | |
| | | NOA = 33 | | | | | NOA = 55 | | | | | NOA = 9 | | | | | NOA = 34 | | | | | |
| Mean | (±SD) | Min. | Max. | NOS | Mean | (±SD) | Min. | Max. | NOS | Mean | (±SD) | Min. | Max. | NOS | Mean | (±SD) | Min. | Max. | NOS | | | |
| Arsenic, total dissolved | 0.005 (±0.002) ND | 0.002 ND | 0.009 ND | 22 0 | 0.007 (±0.005) 0.007 | 0.002 0.007 | 0.02 0.007 | 38 1 | 0.007 (±0.003) ND | 0.004 ND | 0.011 ND | 6 0 | 0.027 (±0.015) ND | 0.002 ND | 0.05 ND | 31 0 | 0.032 | | | | | |
| Boron, total dissolved | 0.15 (±0.05) ND | 0.09 ND | 0.25 ND | 26 0 | 0.11 (±0.03) 0.08 | 0.06 0.08 | 0.18 0.08 | 34 1 | 0.19 (±0.12) ND | 0.07 ND | 0.41 ND | 6 0 | 0.36 (±0.25) ND | 0.12 ND | 0.88 ND | 30 0 | 0.36 | | | | | |
| Lithium, total dissolved | 0.029 (±0.004) ND | 0.022 ND | 0.039 ND | 26 0 | 0.039 (±0.013) 0.041 | 0.013 0.04 | 0.075 0.042 | 41 2 | 0.048 (±0.016) ND | 0.026 ND | 0.074 ND | 8 0 | 0.067 (±0.023) ND | 0.03 ND | 0.104 ND | 31 0 | 0.062 | | | | | |
| Manganese, total dissolved | 0.002 (±0.001) ND | 0.001 ND | 0.004 ND | 9 0 | 0.011 (±0.019) 0.004 | 0.001 0.003 | 0.08 0.006 | 20 2 | 0.003 (±0.003) ND | 0.001 ND | 0.006 ND | 3 0 | 0.463 (±0.485) ND | 0.001 ND | 1.21 ND | 24 0 | 0.078 | | | | | |
| Selenium, total dissolved | 0.003 (±0.001) ND | 0.001 ND | 0.005 ND | 17 0 | 0.003 (±0.001) 0.002 | 0.001 0.002 | 0.006 0.002 | 27 1 | 0.003 (±0.001) ND | 0.002 ND | 0.005 ND | 6 0 | 0.005 (±0.005) ND | 0.002 ND | 0.019 ND | 23 0 | 0.007 | | | | | |
| Vanadium, total dissolved | 0.002 (±0.000) ND | 0.002 ND | 0.002 ND | 8 0 | 0.004 (±0.005) 0.005 | 0.002 0.005 | 0.02 0.005 | 19 1 | 0.003 (±0.002) ND | 0.002 ND | 0.006 ND | 3 0 | 0.015 (±0.036) ND | 0.002 ND | 0.14 ND | 14 0 | 0.124 | | | | | |
| Parameters Detected Sporadically in Groundwater in Offsite EMF Wells | | | | | | | | | | | | | | | | | | | | | | |
| Cadmium, total dissolved | 0.001 (±0.0002) 0.001 (±0.0002) | 0.0003 0.0003 | 0.001 0.001 | 9 9 | 0.001 (±0.0002) 0.001 | 0.0001 0.001 | 0.001 0.001 | 18 1 | 0.001 (±0.000) ND | 0.001 ND | 0.001 ND | 2 0 | 0.002 (±0.002) ND | 0.0004 ND | 0.008 ND | 15 0 | 0.006 | | | | | |
| Nickel, total dissolved | 0.01 (±0.003) ND | 0.01 ND | 0.02 ND | 8 0 | 0.01 (±0.00) ND | 0.01 ND | 0.01 ND | 13 0 | 0.01 (±0.00) ND | 0.01 ND | 0.01 ND | 2 0 | 0.03 (±0.03) ND | 0.01 ND | 0.09 ND | 14 0 | 0.01 | | | | | |
| Parameters Related to the Presence of Silt or to Well Construction Materials | | | | | | | | | | | | | | | | | | | | | | |
| Aluminum, total dissolved | 0.1 (±0.24) ND | 0.02 ND | 0.93 ND | 14 0 | 0.03 (±0.01) 0.05 | 0.02 0.05 | 0.06 0.05 | 16 1 | 0.04 (±0.03) ND | 0.02 ND | 0.07 ND | 3 0 | 0.03 (±0) ND | 0.02 ND | 0.08 ND | 11 0 | 0.68 | | | | | |
| Copper, total dissolved | 0.005 (±0.003) ND | 0.004 ND | 0.012 ND | 10 0 | 0.005 (±0.002) 0.002 | 0.004 0.002 | 0.01 0.002 | 15 1 | 0.042 (±0.036) ND | 0.004 ND | 0.083 ND | 5 0 | 0.005 (±0.001) ND | 0.004 ND | 0.009 ND | 12 0 | 0.022 | | | | | |
| Iron, total dissolved | 0.3 (±0.56) ND | 0.07 ND | 2 ND | 12 0 | 0.59 (±1.1) ND | 0.05 ND | 4.4 ND | 22 0 | 0.06 (±0.01) ND | 0.05 ND | 0.07 ND | 3 0 | 0.5 (±1) ND | 0.05 ND | 2.7 ND | 20 0 | 1.1 | | | | | |

Abbreviations: SD = Standard Deviation; Min. = Minimum; Max. = Maximum; NOS = Number of samples in statistical calculations (samples with concentrations below detection limit - with "U" qualifier - not included), ND = below detection limit).

(a) 2 S.D. = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

(b) Secondary Standard. NR = Not currently regulated.

Table 4.4-25
Nutrient and Fluoride Concentrations in Offsite Groundwater

| Parameter | UNIMPACTED WELLS | | | | | | | | | | | | | REPRESENTATIVE CONCENTRATIONS (2 S.D.) (a) | | | | | | | |
|---------------------------|--|---------|------|---------------------|----|---|---------|------|---------------------|----|---|---------|------|---|--|-----|--------|-------|------|---------------------|-----|
| | Portneuf River Regime Representative Wells 510, 511, 512, 513 and Wells 506, 507, 509, 520 | | | | | Bannock Range Regime Representative Well Idaho Power and Wells 500, 502, 504, 508, 514, 516, 519, NPH, Rowlands, Tank Farm, TW-111, TW-115 | | | | | Michaud Flats Regime Wells 501, 515, and Lindley | | | | IMPACTED WATER Wells 503, 505, 517, 518, TW-9S, TW-12S, Frontier, Old Pilot House, and Batiste Spring | | | | | | |
| | Mean | (±SD) | Min. | NOA = 0 Max. NOS | | Mean | (±SD) | Min. | NOA = 0 Max. NOS | | Mean | (±SD) | Min. | | NOA = 0 Max. NOS | | Mean | (±SD) | Min. | NOA =34 Max. NOS | |
| Ammonia (NH3 as N) | 0.5 | (±0.0) | 0.4 | 0.5 | 9 | 0.5 | (±0.0) | 0.5 | 0.5 | 13 | 0.5 | (±0.1) | 0.4 | 0.5 | 3 | 5.6 | (±18) | 0.2 | 72 | 16 | 0.8 |
| Nitrate (NO3 as N) | 2.9 | (±0.7) | 1.7 | 4.6 | 33 | 1.4 | (±0.6) | 0.5 | 4.6 | 52 | 3.3 | (±2.6) | 1.6 | 7.7 | 9 | 7.1 | (±6.5) | 1.5 | 33 | 34 | 4.5 |
| Orthophosphate (PO4 as P) | 0.04 | (±0.02) | 0.02 | 0.12 | 25 | 0.03 | (±0.01) | 0.02 | 0.07 | 36 | 0.03 | (±0.01) | 0.02 | 0.04 | 7 | 6.7 | (±13) | 0.06 | 72 | 34 | 1.8 |
| Phosphorus, total | 0.04 | (±0.03) | 0.02 | 0.15 | 30 | 0.15 | (±0.75) | 0.02 | 4.6 | 37 | 0.03 | (±0.02) | 0.02 | 0.05 | 7 | 7.3 | (±14) | 0.06 | 77 | 34 | 3.1 |
| Fluoride | 0.2 | (±0.1) | 0.2 | 0.4 | 33 | 0.7 | (±0.2) | 0.2 | 1 | 52 | 0.5 | (±0.1) | 0.4 | 0.6 | 9 | 0.6 | (±0.4) | 0.2 | 13 | 26 | 0.7 |

(a) 2 S.D. = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

Table 4.4-26
Concentrations of Major Ions and Physical Parameters in Offsite Groundwater

| Parameter | UNIMPACTED WELLS | | | | | | | | | | | | | | | IMPACTED WATER | | | | | REPRESENTATIVE CONCENTRATIONS (2 S.D.) (a) |
|---------------------------------|--|---------|------|------|-----|---|---------|------|-------|-----|---|---------|------|-------|-----|--|---------|------|------|-----|---|
| | Portneuf River Regime Representative Wells 510, 511, 512, 513 and Wells 508, 507, 509, 520 | | | | | Bannock Range Regime Representative Well Idaho Power and Wells 500, 502, 504, 508, 514, 518, 519, NPH, Rowlands, Tank Farm, TW-111, TW-11S | | | | | Michaud Flats Regime Wells 501, 515, and Lindley | | | | | Wells 503, 505, 517, 518, TW-9S, TW-12S, Frontier, Old Pilot House, and Batiste Spring | | | | | |
| | Mean | (±SD) | Min. | Max. | NOS | Mean | (±SD) | Min. | Max. | NOS | Mean | (±SD) | Min. | Max. | NOS | Mean | (±SD) | Min. | Max. | NOS | |
| COMMON IONS (mg/l) | | | | | | | | | | | | | | | | | | | | | |
| Alkalinity, bicarbonate | 280 | (±13) | 241 | 304 | 33 | 176 | (±30) | 126 | 266 | 52 | 205 | (±52) | 162 | 300 | 9 | 284 | (±54) | 189 | 355 | 34 | 315 |
| Calcium | 76.1 | (±12.9) | 44 | 99 | 33 | 49.4 | (±9.4) | 15.4 | 77 | 51 | 86 | (±24) | 46 | 120 | 9 | 99 | (±23) | 53 | 163 | 34 | 105 |
| Chloride | 50.5 | (±13.2) | 20 | 70.7 | 33 | 34.3 | (±17.1) | 16 | 104 | 48 | 166.6 | (±75.2) | 103 | 276 | 9 | 119 | (±92) | 34.9 | 274 | 34 | 177 |
| Magnesium | 30.2 | (±3.3) | 23.8 | 35.6 | 33 | 17 | (±3.5) | 10.3 | 32 | 52 | 31.5 | (±9.4) | 20.8 | 45.3 | 9 | 40 | (±12) | 19.9 | 65 | 34 | 42 |
| Potassium | 6.4 | (±0.6) | 4.3 | 7.4 | 33 | 5.1 | (±1.4) | 2.9 | 8.8 | 52 | 9 | (±3.4) | 4.7 | 13.6 | 9 | 44.6 | (±50.2) | 6.4 | 138 | 33 | 13 |
| Sodium | 41.4 | (±6.1) | 30.9 | 53.5 | 33 | 33.3 | (±11) | 15.4 | 81 | 52 | 82.3 | (±53) | 33.7 | 153.5 | 9 | 92 | (±44.9) | 34.9 | 175 | 33 | 64 |
| Sulfate | 55 | (±11) | 41 | 90 | 33 | 45 | (±13) | 15 | 95 | 51 | 111 | (±51) | 70 | 186 | 9 | 183 | (±92) | 61 | 574 | 34 | 79 |
| PHYSICAL PARAMETERS | | | | | | | | | | | | | | | | | | | | | |
| pH | | | 7.04 | 9.3 | 25 | | | 7.1 | 10.11 | 39 | | | 7.09 | 9 | 7 | | | 6.32 | 7.33 | 24 | 6.9 to 9.4 (b) |
| Specific conductance (µmhos/cm) | 776 | (±81) | 593 | 855 | 25 | 581 | (±174) | 403 | 1110 | 39 | 1176 | (±515) | 639 | 1759 | 7 | 1256 | (±479) | 596 | 1956 | 24 | 1052 |
| Temperature (°C) | 13.6 | (±1.4) | 12.1 | 17.6 | 25 | 14 | (±2.2) | 10.5 | 22.8 | 39 | 12.1 | (±2.4) | 8 | 15.3 | 7 | 14.4 | (±1.8) | 10 | 18.1 | 24 | 11.4 to 17.9 |
| TDS (mg/l) | 485 | (±40) | 420 | 580 | 33 | 325 | (±60) | 160 | 570 | 50 | 700 | (±269) | 470 | 1120 | 9 | 850 | (±313) | 370 | 1340 | 33 | 746 |
| Redox (mV) | 120 | (±30) | 76 | 154 | 7 | 59 | (±43) | -28 | 122 | 10 | 70 | | 56 | 83 | 2 | 37 | | -117 | 137 | 7 | |

(a) 2 S.D. = Mean for 16 representative wells plus two times Standard Deviation for the 16 wells.

(b) 9.4 pH is thought to be an outlier. 8.9 pH is the upper representative value.

Table 4.4-27
Organic Compounds Detected in Groundwater in Offsite Wells

| Parameter | Sampling Date | Representative Levels/Unimpacted Areas Portneuf River Regime | | | | Bannock Range Regime | | Michaud Flats Regime | Impacted Wells | | | | | | Practical Quantitation Limits (mg/l) |
|--|---------------|---|-------|------------------------|-------|-------------------------|--------|------------------------|----------------|-------|----------|-----------|--------|-------|---|
| | | Representative Wells 511 | 513 | Unimpacted Well 507 | 509 | Unimpacted Wells 502 | TW-113 | Unimpacted Well 501 | 503 | 505 | Frontier | Old Pilot | TW-123 | TW-93 | |
| <u>VOLATILE ORGANIC COMPOUNDS</u> | | | | | | | | | | | | | | | |
| 2-Butanone | Jun-92 | | 0.004 | 0.006 | | | | | | | 0.007 | | | | |
| Acetone | Jun-92 | 0.044 | 0.1 | 0.481 | 1.656 | 0.108 | | 1.04 | | | | | | | 0.1 |
| Acetone | Sep-92 | | | | | 0.12 | | | 0.21 | | | | | 3.275 | |
| Acetone | Dec-92 | | | | | | | | | | | | | | |
| Carbon disulfide | Jun-92 | 0.027 | 0.033 | 0.026 | 0.168 | 0.005 | 0.001 | | | | | | | | 0.005 |
| Ethyl benzene | Jun-92 | | | | | | | 0.002 | | | | | | | 0.005 |
| Tetrachloroethene | Jun-92 | 0.003 | | 0.003 | 0.002 | | | | | 0.001 | | | | | |
| Tetrachloroethene | Sep-92 | 0.001 | | 0.002 | 0.003 | | | | | | | | | | |
| Tetrachloroethene | Dec-92 | 0.003 | | 0.002 | 0.003 | | | | | | | | | | 0.01 |
| Toluene | Jun-92 | | | | | | | | | | | | 0.002 | | |
| Trichloroethene | Jun-92 | | | | | | | | 0.004 | | | 0.001 | | 0.001 | |
| Trichloroethene | Sep-92 | | | | | | | | | | | | | 0.001 | 0.01 |
| Xylenes, total | Jun-92 | | | | | | | 0.011 | | | | | | | 0.01 |
| Xylenes, total | Sep-92 | | | | | | | 0.001 | | | | | | | |
| <u>SEMIVOLATILE ORGANIC COMPOUNDS</u> | | | | | | | | | | | | | | | |
| Bis(2-ethylhexyl)phthalate | Jun-92 | 0.017 | | | 0.005 | | | 0.002 | 0.001 | 0.002 | | | | 0.001 | 0.005 |
| Bis(2-ethylhexyl)phthalate | Sep-92 | 0.013 | 0.002 | 0.004 | 0.006 | 0.004 | 0.005 | 0.01 | 0.003 | 0.011 | | 0.001 | 0.002 | 0.005 | |
| Bis(2-ethylhexyl)phthalate | Dec-92 | 0.012 | | 0.003 | 0.011 | 0.003 | | 0.014 | 0.012 | 0.007 | | | | | 0.005 |
| Di-n-butyl phthalate | Dec-92 | 0.002 | | | | | | | | 0.001 | | | | 0.004 | 0.005 |
| Di-n-octyl phthalate | Dec-92 | | | | | | | | | 0.002 | | | | | 0.005 |
| Diethyl phthalate | Jun-92 | | | | | | | | | | | | 0.001 | | 0.005 |
| Dimethyl phthalate | Dec-92 | | | | | | | | | | | | 0.019 | 0.004 | |

Tables for Section 4.5

Table 4.5-1
Potential Sources of Concentrations of Parameters in Springs and Gaining Reach of Portneuf River

| Parameter | Representative Groundwater Concentrations (18 Wells) | Upgradient Wells Barnock Range (a) | Upgradient Wells Portneuf River (a) | Well 318 Undetermined | Well 317 Undetermined | TW-12S Barnock Range? | Well 327 Barnock Range? | Frontier Well Barnock Range? | Well 503 Portneuf River? | Well 505 Portneuf River (a) | Batiste Spring (b) Barnock Range (a) | Well 504 Barnock Range (a) | TW-11S Barnock Range (a) | TW-11I Barnock Range (a) |
|---|--|---------------------------------------|--|--------------------------|--------------------------|--------------------------|----------------------------|---------------------------------|-----------------------------|--------------------------------|---|-------------------------------|-----------------------------|-----------------------------|
| Alkalinity, bicarbonate, mg/l | 75 to 315 | 118 to 196 | 226 to 370 | 540 | 1240 | 220 | 356 | 274 | 328 | 287 | 195 | 163 | 179 | 196 |
| Calcium, mg/l | 40 to 105 | 35 to 73 | 50 to 101 | 561 | 374 | 98 | 134 | 87 | 105 | 74 | 63 | 44 | 52 | 51 |
| Chloride, mg/l | ND to 177 | 35 to 54 | 23 to 82 | 141 | 119 | 60 | 73 | 50 | 68 | 57 | 44 | 31 | 31 | 30 |
| Magnesium, mg/l | 11 to 42 | ND to 35 | 23 to 39 | 206 | 210 | 37.4 | 48.5 | 31.0 | 35.0 | 29.5 | 22.4 | 14.2 | 17.1 | 16.9 |
| Potassium, mg/l | 4 to 13 | 4 to 12 | 5 to 8 | 200 | 18.6 | 19.3 | 11.6 | 6.8 | 7.8 | 6.2 | 7.3 | 4.6 | 3.8 | 5.2 |
| Sodium, mg/l | 7 to 64 | 10 to 31 | 25 to 56 | 369 | 536 | 95.8 | 82.9 | 57.1 | 68.7 | 40.0 | 42.6 | 32.4 | 31.0 | 36.0 |
| Sulfate, mg/l | 14 to 79 | 6 to 47 | 35 to 74 | 2,400 | 1,800 | 210 | 290 | 170 | 230 | 82 | 81 | 50 | 49 | 40 |
| Specific conductance at 25°C, µmhos | 387 to 1052 | 286 to 708 | 611 to 933 | 6,495 | 4,404 | 978.5 | 1,359 | 1,048 | 1,166 | 903.5 | 662.3 | 550.0 | 498.8 | 525.5 |
| pH | 6.9 to 9.4 | 6.9 to 9.4 | 7.1 to 8.9 | 2.9 | 6.2 | 6.4 | 6.6 | 7.0 | 7.1 | 7.5 | 7.1 | 7.9 | 7.4 | 7.5 |
| Temperature, °C | 11.4 to 17.9 | 13 to 19 | 12 to 15 | 19.5 | 16.7 | 14.8 | 14.3 | 14.1 | 14.6 | 13.4 | 11.8 | 14.7 | 12.5 | 13.6 |
| Total dissolved solids, mg/l | 175 to 746 | 163 to 468 | 394 to 591 | 10,000 | 3,970 | 731 | 865 | 610 | 795 | 505 | 405 | 316 | 300 | 289 |
| Ammonia (NH ₃ as N), mg/l | ND to 0.8 | ND to 0.2 | ND to 0.9 | 18 | ND | 1.1 | ND | ND | 2.2 | ND | ND | ND | ND | ND |
| Nitrate (NO ₃ as N), mg/l | ND to 4.5 | 0.3 to 1.7 | 0.9 to 4.3 | 1.1 | 1.5 | 6.7 | 2.4 | 1.6 | 3.9 | 2.3 | 2.2 | 1.2 | 1.3 | 1.4 |
| Orthophosphate (PO ₄ as P), mg/l | ND to 1.8 | ND to 0.33 | ND to 0.39 | 2,500 | 91 | 31 | 6.3 | 2.2 | 4.2 | 0.08 | 0.88 | 0.03 | 0.03 | 0.03 |
| Phosphorus, total, mg/l | ND to 3.1 | ND to 0.31 | ND to 0.13 | 2,000 | 91 | 33 | 6.8 | 2.2 | 4.4 | 0.08 | 0.91 | 0.06 | 0.03 | 0.06 |
| Fluoride, mg/l | 0.03 to 0.7 | 0.1 to 0.8 | 0.1 to 0.4 | 740 | 0.14 | 1.05 | 1.05 | 0.5 | 1.1 | 0.3 | 0.6 | 0.8 | 0.7 | 0.8 |
| Aluminum, mg/l | ND to 0.68 | ND to 0.54 | ND to 0.9 | 270 | 0.04 | ND | ND | ND | 5.4 | 0.08 | ND | 1.05 | ND | ND |
| Antimony, mg/l | 0.04 to 0.20 | 0.04 to 0.23 | ND to 0.10 | ND | 0.07 | ND | ND | ND | 0.06 | ND | ND | 0.05 | ND | ND |
| Arsenic, mg/l | ND to 0.032 | ND to 0.021 | 0.001 to 0.009 | 0.288 | 0.271 | 0.034 | 0.031 | 0.020 | 0.018 | 0.005 | 0.008 | 0.006 | 0.003 | 0.005 |
| Barium, mg/l | 0.02 to 0.22 | 0.02 to 0.16 | 0.07 to 0.19 | 0.21 | 0.13 | 0.04 | 0.10 | 0.15 | 0.13 | 0.15 | 0.05 | 0.06 | 0.07 | 0.07 |
| Beryllium, mg/l | 0.0007 to 0.003 | 0.002 to 0.002 | 0.0004 to 0.004 | 0.062 | ND | 0.002 | ND | ND | ND | ND | ND | ND | 0.002 | 0.002 |
| Boron, mg/l | ND to 0.36 | ND to 0.39 | ND to 0.37 | 2.80 | 0.59 | 0.22 | 0.17 | 0.14 | 0.17 | 0.16 | 0.12 | 0.13 | 0.08 | 0.08 |
| Cadmium, mg/l | 0.001 to 0.006 | ND to 0.006 | ND to 0.002 | 1.51 | 0.001 | 0.003 | 0.003 | ND | 0.001 | ND | ND | ND | 0.001 | 0.001 |
| Chromium, mg/l | ND to 0.012 | ND to 0.008 | ND to 0.015 | 2.87 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 | ND | ND |
| Cobalt, mg/l | 0.002 to 0.033 | ND to 0.010 | 0.005 to 0.021 | 0.086 | ND | 0.01 | ND | ND | ND | 0.009 | ND | ND | 0.010 | 0.010 |
| Copper, mg/l | ND to 0.022 | ND to 0.027 | ND to 0.036 | 0.630 | 0.016 | ND | 0.004 | ND | ND | ND | 0.004 | ND | 0.006 | ND |
| Iron, mg/l | ND to 1.1 | ND to 0.86 | ND to 1.2 | 78 | 0.21 | 0.40 | 0.01 | ND | 5.1 | 0.30 | ND | ND | 0.28 | 2.52 |
| Lead, mg/l | ND to 0.006 | ND to 0.008 | ND to 0.008 | 0.016 | ND | ND | ND | 0.001 | 0.002 | ND | 0.003 | 0.002 | 0.002 | ND |
| Lithium, mg/l | ND to 0.062 | 0.003 to 0.013 | 0.020 to 0.043 | 0.434 | 0.220 | 0.078 | 0.057 | 0.045 | 0.044 | 0.031 | 0.051 | 0.041 | 0.047 | 0.051 |
| Manganese, mg/l | ND to 0.078 | ND to 0.047 | ND to ND | 6.90 | 0.150 | 0.138 | ND | ND | 0.087 | ND | 0.007 | ND | ND | 0.040 |
| Mercury, mg/l | ND to 0.0013 | ND to 0.0011 | ND to 0.0013 | ND | ND | 0.0002 | ND | 0.0003 | 0.0010 | 0.0003 | ND | 0.0003 | ND | ND |
| Molybdenum, mg/l | ND to 0.07 | ND to 0.02 | ND to 0.08 | 0.12 | ND | ND | ND | ND | 0.03 | ND | ND | ND | ND | ND |
| Nickel, mg/l | 0.01 to 0.01 | ND to 0.01 | ND to ND | 2.0 | ND | 0.05 | ND | ND | 0.01 | ND | ND | ND | ND | ND |
| Selenium, mg/l | ND to 0.007 | 0.0002 to 0.005 | 0.0001 to 0.005 | 0.030 | 0.019 | 0.011 | 0.007 | 0.003 | 0.006 | 0.003 | 0.008 | 0.004 | ND | 0.002 |
| Silver, mg/l | 0.002 to 0.006 | 0.001 to 0.01 | ND to 0.003 | 0.013 | 0.013 | ND | ND | 0.003 | ND | ND | ND | ND | 0.002 | ND |
| Thallium, mg/l | 0.04 to 0.040 | ND to 0.040 | ND to ND | 0.045 | ND | ND | ND | ND | ND | ND | 0.004 | ND | ND | ND |
| Vanadium, mg/l | ND to 0.124 | ND to 0.103 | ND to 0.331 | 11.3 | 0.079 | 0.008 | 0.007 | ND | 0.006 | ND | 0.006 | ND | ND | 0.014 |
| Zinc, mg/l | ND to 0.397 | ND to 0.794 | ND to 0.269 | 15.5 | ND | 0.018 | 0.021 | 0.035 | 0.018 | 0.005 | ND | 0.026 | ND | ND |

Notes:

(a) Hydrogeochemical regimes.

(b) Batiste Spring groundwater sampling station.

Bold = Concentrations exceeding all representative groundwater concentrations.

Italic = Concentrations exceeding concentrations in upgradient wells for the given hydrogeochemical regime.

ND = Not detected/below detection limit.

Table 4.5-2
Potential Sources of Elevated Levels of Parameters at River Station SW17

| Parameter | Representative Groundwater Concentrations | Production Well Water FMC-1 ^(a) 10/90 ^(b) | IWW Ditch Water (Phase I) FSW/IWW01 ^(a) 9/92 ^(b) | Surface Water (Phase I) SW17 ^(a) Mean 7/82 - 4/9/93 ^(b) | Surface Water (Phase II) SW17 ^(a) Mean 7/93 ^(b) |
|---|---|---|---|---|---|
| Alkalinity, bicarbonate, mg/l | 75 to 315 | 187 | 324 | 188.3 | 196 |
| Calcium, mg/l | 40 to 105 | 87.6 | 141J | 62.2 | 64.7 |
| Chloride, mg/l | ND to 17.7 | 96 | 1620 | 54.6 | |
| Magnesium, mg/l | 11 to 42 | 27.7 | 22 | 22.6J | 23.8 |
| Potassium, mg/l | 4 to 13 | 11.2 | 7470J | 8.4 | 6.9 |
| Sodium, mg/l | 7 to 64 | 50.1 | 1450J | 47.7 | 29.7 |
| Sulfate, mg/l | 14 to 79 | 142 | 8400 | 65.4 | 35 |
| Specific conductance at 25°C, µmhos | 387 to 1052 | 925 | NA | 738 | |
| pH | 6.9 to 9.4 | 7.5 | NA | 8.52 | |
| Temperature, °C | 11.4 to 17.9 | 13.5 | NA | 17.6 | |
| Total dissolved solids, mg/l | 175 to 746 | 585 | 7460 | 403.3J | 340 |
| Ammonia (NH ₃ as N), mg/l | ND to 0.8 | NA | 288 | ND | 0.5 |
| Nitrate (NO ₃ as N), mg/l | ND to 4.5 | 1.9 | 18.4 | 1.29J | 0.57 |
| Orthophosphate (PO ₄ as P), mg/l | ND to 1.8 | 0.45 | 2210 | 0.32J | 0.08 |
| Phosphorus, total, mg/l | ND to 3.1 | 0.5 | 2590 | 0.64 | 0.14 |
| Fluoride, mg/l | 0.03 to 0.7 | 0.4 | 61.6 | 0.65 | 0.3 |
| Aluminum, mg/l | ND to 0.68 | NA | 7.66J | 1.02 | 1.88 |
| Antimony, mg/l | 0.04 to 0.20 | NA | ND | ND | ND |
| Arsenic, mg/l | ND to 0.32 | 0.0115 | 1.759J | 0.0063J | 0.0029 |
| Barium, mg/l | 0.02 to 0.22 | 0.113 | 0.27 | 0.081 | 0.114 |
| Beryllium, mg/l | 0.0007 to 0.003 | NA | ND | ND | 0.001 |
| Boron, mg/l | ND to 0.36 | NA | 4.53 | 0.38J | 0.09 |
| Cadmium, mg/l | 0.001 to 0.006 | 0.003 | 0.0341J | 0.0003J | ND |
| Chromium, mg/l | ND to 0.012 | 0.006 | ND | 0.002J | 0.001 |
| Cobalt, mg/l | 0.002 to 0.033 | NA | ND | 0.008 | 0.004 |
| Copper, mg/l | ND to 0.022 | 0.004 | 0.163 | 0.015 | 0.007 |
| Iron, mg/l | ND to 1.1 | 0.041 | 4.99J | 0.413 | 1.465 |
| Lead, mg/l | ND to 0.006 | 0.001 | ND | 0.002 | 0.001 |
| Lithium, mg/l | ND to 0.062 | NA | 1.599 | 0.049 | 0.027 |
| Manganese, mg/l | ND to 0.078 | 0.0394 | 0.187 | 0.023 | 0.048 |
| Mercury, mg/l | ND to 0.0013 | NA | ND | ND | ND |
| Molybdenum, mg/l | ND to 0.07 | NA | 0.19 | ND | ND |
| Nickel, mg/l | 0.01 to 0.01 | NA | 0.17 | 0.013 | 0.01 |
| Selenium, mg/l | ND to 0.007 | 0.0025 | 4.217J | 0.0053 | ND |
| Silver, mg/l | 0.002 to 0.006 | 0.004 | 0.035 | 0.0029J | ND |
| Thallium, mg/l | 0.04 to 0.040 | NA | 0.318J | ND | ND |
| Vanadium, mg/l | ND to 0.124 | 0.0061 | 0.83 | 0.027J | 0.002 |
| Zinc, mg/l | ND to 0.397 | 0.0106 | 5.25 | 0.039J | 0.020 |
| Gross alpha | | | 186.50 | 5.80 | 1.0 |
| Gross beta | | | 103.58 | 4.89 | 9.90 |
| Radium-226 | | | | 0.94 | 0.50 |
| Radium-228 | | | | 0.50 | 0.50 |

Notes:

(a) Sample ID.

ND = Not detected/below detection limit.

J = Estimated value.

(b) Sample date.

NA = Not analyzed.

Bold = Concentrations exceeding all representative groundwater concentrations.

Table 4.5-2A
Analysis Results for Additional Water Samples Collected from IWW Ditch

| Parameter | HEIC Sample | | Phase II Samples | | | | | | | | | | | | | | | | Well 125 | | |
|---------------------------|----------------|-----------------|------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------------|------------------------|------------------------|
| | HEIC 041W | | 03071WA | | 03071WB | | 03071WE | | 03071WF | | 03071WG | | 03071WH | | 03071WI | | 03071WJ | | Range of Values | | |
| | Value Reported | Detection Limit | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Mean of Phase II Samples | Minimum Value Reported | Maximum Value Reported |
| Alkalinity, bicarbonate | | | 168 | | 170 | | 170 | | 178 | | 194 | | 188 | | 180 | | 164 | | 176.5 | 176 | 199 |
| Alkalinity, carbonate | | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | 0 | 5 |
| Aluminum, dissolved | | | 0.023 | U | 0.023 | U | 0.023 | U | 0.023 | U | 0.023 | U | 0.023 | U | 0.023 | U | 0.023 | U | 0.0115 | | |
| Aluminum, total | | | 0.023 | U | | | 0.023 | U | 0.023 | U | 0.023 | U | 0.023 | U | 0.023 | U | 0.023 | U | 0.0115 | 0.023 | 0.054 |
| Ammonia (NH3 as N) | | | 0.5 | U | | | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.25 | 0.2 | 0.5 |
| Antimony, dissolved | | | 0.045 | U | 0.045 | U | 0.045 | U | 0.045 | U | 0.045 | U | 0.045 | U | 0.045 | U | 0.045 | U | 0.0225 | | |
| Antimony, total | ND | 0.06 | 0.045 | U | | | 0.045 | U | 0.045 | U | 0.045 | U | 0.045 | U | 0.045 | U | 0.045 | U | 0.0225 | 0.039 | 0.15 |
| Arsenic, dissolved | | | 0.00667 | | 0.00729 | | 0.00979 | | 0.00922 | | 0.01064 | | 0.00638 | | 0.00875 | | 0.00847 | | 0.00546125 | 0.0049 | 0.0066 |
| Arsenic, total | 0.017 | 0.01 | 0.00686 | | | | 0.00679 | | 0.00671 | | 0.00739 | | 0.00741 | | 0.00657 | | 0.00633 | | 0.0058571 | 0.00362 | 0.0096 |
| Barium, dissolved | | | 0.07917 | | 0.08288 | | 0.08637 | | 0.08408 | | 0.08146 | | 0.08375 | | 0.07961 | | 0.08037 | | 0.08221125 | 0.0825 | 0.0929 |
| Barium, total | | | 0.08255 | | | | 0.08615 | | 0.08288 | | 0.08397 | | 0.08463 | | 0.08299 | | 0.0855 | | 0.08409571 | 0.076 | 0.16 |
| Beryllium, dissolved | | | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.0005 | | |
| Beryllium, total | ND | 0.005 | 0.001 | U | | | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.0005 | 0.001 | 0.003 |
| Boron, dissolved | | | 0.17381 | J | 0.18236 | J | 0.18299 | J | 0.1909 | J | 0.17254 | J | 0.17727 | J | 0.18435 | J | 0.17555 | J | 0.17997125 | | |
| Boron, total | | | 0.18219 | J | | | 0.17882 | J | 0.19426 | J | 0.18145 | J | 0.22324 | J | 0.18744 | J | 0.22697 | J | 0.19491 | 0.054 | 0.27139 |
| Cadmium, dissolved | | | 0.001 | U | 0.001 | U | 0.0033 | J | 0.0035 | J | 0.001 | U | 0.001 | U | 0.0026 | J | 0.001 | U | 0.0013 | 0.004 | 0.004 |
| Cadmium, total | ND | 0.005 | 0.001 | U | | | 0.00307 | J | 0.0041 | J | 0.001 | U | 0.001 | U | 0.0028 | J | 0.001 | U | 0.0014957 | 0.0007 | 0.0142 |
| Calcium | | | 63.8283 | | | | 65.27745 | | 64.20803 | | 64.86902 | | 65.96515 | | 64.52338 | | 63.11859 | | 64.5411314 | 41.6 | 49.7 |
| Calcium, dissolved | | | 62.90637 | | 64.28277 | | 64.98514 | | 65.02318 | | 64.44879 | | 65.34284 | | 62.9878 | | 62.80162 | | 64.1223138 | | |
| Chloride | | | 78 | | | | 88 | | 78 | | 83.97 | | 82.97 | | 80 | | 80 | | 81.5628571 | 28.9 | 46.1 |
| Chromium, dissolved | | | 0.00214 | | 0.002 | | 0.00223 | | 0.00209 | | 0.00202 | | 0.00209 | | 0.00221 | | 0.00208 | | 0.0021075 | 0.005 | 0.013 |
| Chromium, total | ND | 0.01 | 0.0028 | J | | | 0.00277 | J | 0.00309 | J | 0.00282 | J | 0.00276 | J | 0.00307 | J | 0.00282 | J | 0.00287571 | 0.0018 | 0.01 |
| Cobalt, dissolved | | | 0.00577 | | 0.00759 | | 0.00847 | | 0.00957 | | 0.0073 | | 0.00949 | | 0.00821 | | 0.00828 | | 0.007585 | | |
| Cobalt, total | | | 0.00832 | | | | 0.00876 | | 0.00847 | | 0.00942 | | 0.00872 | | 0.00869 | | 0.00869 | | 0.0084857 | 0.008 | 0.027 |
| Copper, dissolved | | | 0.0045 | U | 0.00484 | U | 0.01033 | U | 0.01289 | U | 0.01033 | U | 0.01307 | U | 0.004 | U | 0.00512 | U | 0.0040675 | 0.003 | 0.0074 |
| Copper, total | ND | 0.025 | 0.01111 | U | | | 0.01064 | U | 0.01498 | U | 0.0158 | U | 0.01001 | U | 0.0103 | U | 0.01271 | U | 0.0061107 | 0.002 | 0.0043 |
| Dissolved oxygen | | | 6.2 | | 6.4 | | 6.5 | | 6.2 | | 6.2 | | 6.2 | | 6.2 | | 6.1 | | 6.25 | | |
| Fluoride | 0.7 | 0.2 | 0.7 | | | | 0.7 | | 0.7 | | 0.6 | | 0.6 | | 0.7 | | 0.6 | | 0.65714286 | 1.07 | 1.32 |
| Iron, dissolved | | | 0.069 | U | 0.069 | U | 0.069 | U | 0.069 | U | 0.069 | U | 0.069 | U | 0.069 | U | 0.069 | U | 0.0345 | 0.004 | 0.017 |
| Iron, total | | | 0.069 | U | | | 0.069 | U | 0.069 | U | 0.069 | U | 0.069 | U | 0.069 | U | 0.069 | U | 0.0345 | 0.01 | 0.169 |
| Lead, dissolved | | | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.0005 | 0.001 | 0.002 |
| Lead, total | ND | 0.003 | 0.001 | U | | | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.0005 | 0.001 | 0.002 |
| Lithium, dissolved | | | 0.04408 | U | 0.04446 | U | 0.04541 | U | 0.04446 | U | 0.04417 | U | 0.04408 | U | 0.04246 | U | 0.04332 | U | 0.0224025 | | |
| Lithium, total | | | 0.05143 | U | | | 0.04522 | U | 0.04627 | U | 0.0457 | U | 0.04436 | U | 0.04427 | U | 0.04704 | U | 0.0231636 | 0.0314 | 0.085 |
| Magnesium | | | 20.40975 | | | | 20.84635 | | 20.4766 | | 20.81502 | | 21.09662 | | 20.24404 | | 20.12109 | | 20.5727814 | 11.4 | 13.9 |
| Magnesium, dissolved | | | 20.11028 | | 20.53523 | | 20.78437 | | 20.80442 | | 20.81424 | | 21.00295 | | 20.02069 | | 19.80084 | | 20.4841275 | | |
| Manganese, dissolved | | | 0.00343 | U | 0.00245 | U | 0.00232 | | 0.00635 | U | 0.00698 | | 0.00747 | | 0.006 | | 0.00551 | | 0.00302958 | 0.001 | 0.002 |
| Manganese, total | | | 0.00514 | | | | 0.00245 | | 0.00919 | | 0.00845 | | 0.01201 | | 0.00723 | | 0.00723 | | 0.00738571 | 0.001 | 0.0182 |
| Mercury, dissolved | | | 0.00006 | U | 0.00006 | U | 0.0001 | U | 0.00007 | U | 0.00006 | U | 0.00006 | U | 0.00009 | U | 0.00009 | U | 0.0000375 | | |
| Mercury, total | ND | 0.0005 | 0.00011 | U | | | 0.00011 | U | 0.00009 | U | 0.00013 | U | 0.00009 | U | 0.00009 | U | 0.00011 | U | 5.214E-05 | 0.0002 | 0.00047 |
| Molybdenum, dissolved | | | 0.013 | U | 0.013 | U | 0.013 | U | 0.01395 | U | 0.013 | U | 0.01383 | U | 0.013 | U | 0.02427 | U | 0.0073156 | | |
| Molybdenum, total | | | 0.01803 | U | | | 0.01372 | U | 0.013 | U | 0.013 | U | 0.013 | U | 0.013 | U | 0.01565 | U | 0.0071 | 0.013 | 0.02 |
| Nickel, dissolved | | | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U | 0.0055 | | |
| Nickel, total | ND | 0.025 | 0.011 | U | | | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U | 0.011 | U | 0.0055 | 0.007 | 0.02 |
| Nitrate (NO3 as N) | | | 1.25 | | 1.37 | | 1.21 | | 1.21 | | 1.13 | | 1.24 | | 1.26 | | 1.13 | | 1.225 | 0.47 | 0.77 |
| Orthophosphate (PO4 as P) | 0.58 | 0.02 | 0.312 | | 0.48 | | 0.428 | | 0.633 | | 0.385 | | 0.383 | | 0.338 | | 0.3 | | 0.407375 | 0.02 | 0.04 |
| pH | | | 8.8 | | 8.9 | | 8.7 | | 8.7 | | 8.8 | | 8.8 | | 8.5 | | 9 | | 8.775 | 7.27 | 8.42 |
| Phosphorus, total | 0.7 | 0.02 | 0.345 | | 0.515 | | 0.495 | | 0.855 | | 0.47 | | 0.44 | | 0.395 | | 0.335 | | 0.48125 | 0.02 | 0.34 |

Section 4 Nature and Extent of Constituents of Potential Concern

Table 4.5-2A (Cont'd)

| Parameter | NEIC Sample | | Phase II Samples | | | | | | | | | | | | | | | | Well 125 | | |
|--------------------------------|----------------|-----------------|------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------------|------------------------|------------------------|
| | NEIC 041W | | 03071WA | | 03071WB | | 03071WE | | 03071WF | | 03071WG | | 03071WH | | 03071WI | | 03071WP | | Range of Values | | |
| | Value Reported | Detection Limit | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Value Reported | Data Qualifier | Mean of Phase II Samples | Minimum Value Reported | Maximum Value Reported |
| Potassium | | | 7.96479 | | | | 8.23679 | | 9.51707 | | 8.12173 | | 8.29607 | | 7.89505 | | 8.045 | | 8.29807143 | 5.9 | 12.3 |
| Potassium, dissolved | | | 7.81833 | | 7.94387 | | 8.19496 | | 9.61424 | | 8.26541 | | 8.26469 | | 7.79391 | | 7.62304 | | 8.18250625 | | |
| Radon | | | 120 | | 77 | | 103 | | 98 | | 81 | | 81 | | 101 | | 101 | | 95.35 | 40 | 153 |
| Selenium, dissolved | | | 0.002 | U | 0.002 | U | 0.002 | U | 0.002 | U | 0.002 | U | 0.002 | U | 0.002 | U | 0.002 | U | 0.001 | 0.002 | 0.002 |
| Selenium, total | ND | 0.005 | 0.002 | U | | | 0.002 | U | 0.002 | U | 0.002 | U | 0.002 | U | 0.002 | U | 0.002 | U | 0.001 | 0.001 | 0.0031 |
| Silver, dissolved | | | 0.004 | U | 0.004 | U | 0.004 | U | 0.004 | U | 0.004 | U | 0.004 | U | 0.004 | U | 0.004 | U | 0.002 | 0.003 | 0.008 |
| Silver, total | ND | 0.01 | 0.004 | U | | | 0.004 | U | 0.004 | U | 0.004 | U | 0.004 | U | 0.004 | U | 0.004 | U | 0.002 | 0.002 | 0.004 |
| Sodium | | | 58.10831 | | | | 61.15139 | | 54.90327 | | 58.134 | | 59.20499 | | 57.1022 | | 59.18787 | | 58.2560087 | 47.6 | 57 |
| Sodium, dissolved | | | 57.36854 | | 52.80345 | | 60.13637 | | 58.74538 | | 58.89979 | | 59.17864 | | 56.88919 | | 56.71009 | | 57.5914313 | | |
| Specific conductance, at 25 °C | | | 1351 | | 592 | | 644 | | 684 | | 200 | | 200 | | 696 | | 712 | | 634.875 | 414 | 567 |
| Sulfate | | | 75 | | | | 75 | | 78 | | 72 | | 80 | | 77 | | 69 | | 75.1428571 | 38 | 47 |
| Temperature | | | 22.1 | | 18.5 | | 22.1 | | 23.3 | | 24.2 | | 24.2 | | 18.7 | | 19.9 | | 21.6375 | 14.8 | 18.3 |
| Thallium, total | ND | 0.01 | 0.001 | U | | | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.0005 | 0.0005 | 0.004 |
| Thallium, dissolved | | | 0.001 | U | 0.001 | U | 0.001 | U | 0.001 | U | 0.00151 | | 0.001 | U | 0.001 | U | 0.001 | U | 0.0006283 | | |
| Total dissolved solids | | | 490 | | 400 | | 490 | | 430 | | 410 | | 440 | | 460 | | 1810 | | 616.25 | 300 | 390 |
| Total suspended solids | | | 4 | U | 4 | U | 4 | U | 6 | U | 4 | U | 4 | U | 4 | U | 4 | U | 4.25 | | |
| Vanadium, dissolved | | | 0.002 | U | 0.00212 | U | 0.00359 | U | 0.00429 | U | 0.00249 | U | 0.00475 | U | 0.002 | U | 0.00304 | U | 0.0015175 | 0.0045 | 0.009 |
| Vanadium, total | | | 0.00442 | U | | | 0.00242 | U | 0.00412 | U | 0.00525 | U | 0.0023 | U | 0.00377 | U | 0.00515 | U | 0.0018593 | 0.002 | 0.12 |
| Zinc, dissolved | | | 0.01866 | U | 0.01232 | U | 0.00999 | U | 0.00803 | U | 0.01408 | U | 0.00723 | U | 0.00677 | U | 0.00843 | U | 0.0053456 | 0.003 | 0.0157 |
| Zinc, total | ND | 0.02 | 0.01503 | U | | | 0.01379 | U | 0.03087 | U | 0.01137 | U | 0.01964 | U | 0.01938 | U | 0.01835 | U | 0.0091736 | 0.0051 | 0.065 |
| Radiological Activities | | | | | | | | | | | | | | | | | | | | | |
| Gross alpha | | | 2.12 | U | 2.3 | U | 2 | U | 2 | U | 2 | U | 3.42 | U | 2 | U | 2 | U | | 2 | 3.7 |
| Gross beta | | | 4.83 | U | 5.17 | U | 4.94 | U | 5.71 | U | 4.62 | U | 5.53 | U | 5.1 | U | 6.09 | U | | 5.01 | 10.2 |
| Radium-226 | | | 1 | U | 1 | U | 1 | U | 1 | U | 1 | U | 1 | U | 1 | U | 1 | U | | 1 | 1.5 |
| Radium-228 | | | 1 | U | 1 | U | 1 | U | 1 | U | 6.5 | U | 1 | U | 1 | U | 1 | U | | 1 | 1.7 |

Notes:

Italic indicates Phase II mean value calculated using one-half the value of "U" data results.

"U" data qualifier indicates reported value is "non detect" (ND).

"J" data qualifier indicates reported value is estimated.

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Section 4 Nature and Extent of Constituents of Potential Concern

Table 4.5-3
Typical STP Effluent Quality^(a)
Pocatello STP, Pocatello, Idaho

| Parameter | Concentration Range ^(b) | Average Concentration |
|-------------------------|------------------------------------|-----------------------|
| BOD ₅ | < 20 | |
| Total suspended solids | < 20 | |
| Ammonia-nitrogen | 10 - 33 | |
| pH | 7.2 - 7.5 units | |
| Dissolved oxygen | 6 - 7 | |
| Electrical conductivity | 1.7 - 2.1 mS/cm | |
| Arsenic | <0.050 | |
| Cadmium | <0.020 | |
| Chromium | <0.010 | |
| Copper | 0.008 - 0.019 | 0.012 |
| Lead | <0.05 - 0.010 | 0.0016 |
| Mercury | <0.0001 | |
| Nickel | <0.002 - 0.030 | 0.012 |
| Boron | 0.260 - 0.380 | 0.323 |
| Silver | <0.001 - 0.004 | 0.0018 |
| Molybdenum | <0.005 - 0.020 | 0.0067 |
| Zinc | 0.022 - 0.054 | 0.031 |
| Total cyanide | 0.007 - 0.023 | 0.016 |

Notes:

(a) Data collected during 1989.

(b) All units are mg/l unless otherwise noted.

Source: City of Pocatello, Idaho, 1989.

Section 4 Nature and Extent of Constituents of Potential Concern

Table 4.5-4
Parameters with Elevated Concentrations in Surface Water

| Spring Groups | | | | River Locations | | |
|---|-------------------------|-----------------------|--------------------|---------------------------------|------------------------|----------------------|
| I. Batiste System | II. Swanson Road System | III. East Side System | IV. Papoose System | SW20 through SW16 | SW17 | SW12 |
| Metals | | | | | | |
| Arsenic | Arsenic | | | Arsenic | Arsenic ^(a) | |
| Lithium | | | | | Boron ^(a) | |
| | | | | | Copper ^(b) | |
| Common Ions and Specific Conductance | | | | | | |
| Potassium | Sulfate | Sulfate | | Sodium ^(a) | Potassium | |
| Sodium | Specific conductance | Specific conductance | | Sulfate ^(a) | Sulfate | |
| Sulfate | | | | | | Specific conductance |
| Specific conductance | | | | | | |
| Nutrients | | | | | | |
| Nitrate | Ortho-phosphate | Nitrate | Nitrate | Nitrate ^(a) | Ortho-phosphate | |
| Ortho-phosphate | Total phosphorus | | | Ortho-phosphate ^(a) | Total phosphorus | |
| Total phosphorus | | | | Total phosphorus ^(a) | Ammonia | |
| | | | | Fluoride ^(a) | Sodium | |
| | | | | | Nitrate | |

Notes:

(a) Phase I RI.

(b) Phase I and Phase II RI.

Table 4.5-5
Mean Concentrations of Metals Present in Surface Water
for Springs Studied from 1992 through 1993

| Parameter (units in mg/l) | Spring Group | | | | | | | | | | | |
|------------------------------|---------------------|---------------------------------|-----------------------------|------------------------|-----------------------------------|---------------------|--------------------------------|---|---|---------------------------------|-----------------------|-----------------------------|
| | I - Battiste System | | II - Swanson Road System | III - East Side System | | IV - Papoose System | | | | | | |
| | Battiste Spring | Battiste Springs Drainage | Swanson Road Spring | Springs near STP | Spring-fed Pond at FMC Park | Papoose Spring | Papoose Springs Drainage | Papoose Springs Drainage Channel | Papoose Springs Drainage Channel | Papoose Springs Discharge | Siphon Road Spring | Twenty Springs (East) |
| | SW14 | SW11 | SW15 | SW13 | SW09 | SW07 | SW08 | SW5F(a) | SW5E(a) | SW05 | SW04 | SW02 |
| Arsenic | | | | | | | | | | | | |
| Total | 0.015 | 0.006 | 0.007 | 0.003 | 0.003 | 0.003 | 0.004 | 0.002 | 0.004 | 0.004 | 0.003 | 0.004 |
| Dissolved | 0.032 | 0.003 | 0.010 | 0.003 | 0.004 | 0.005 | 0.003 | 0.002 | 0.003 | 0.003 | 0.003 | 0.002 |
| Barium | | | | | | | | | | | | |
| Total | 0.083 | 0.107 | 0.123 | 0.114 | 0.104 | 0.095 | 0.094 | 0.077 | 0.074 | 0.103 | 0.064 | 0.760 |
| Dissolved | 0.061 | 0.086 | 0.114 | 0.112 | 0.089 | 0.075 | 0.081 | 0.079 | 0.076 | 0.089 | 0.062 | 0.063 |
| Boron | | | | | | | | | | | | |
| Total | 0.19 | 0.21 | 0.28 | 0.24 | 0.10 | 0.19 | 0.10 | ND | ND | 0.09 | 0.08 | 0.10 |
| Dissolved | 0.18 | 0.19 | 0.21 | 0.22 | 0.10 | 0.23 | 0.20 | ND | ND | 0.12 | 0.15 | 0.11 |
| Lithium | | | | | | | | | | | | |
| Total | 0.051 | 0.034 | 0.044 | 0.036 | 0.023 | 0.031 | 0.033 | ND | ND | 0.036 | 0.038 | 0.037 |
| Dissolved | 0.053 | 0.038 | 0.041 | 0.042 | 0.023 | 0.033 | 0.037 | 0.024 | 0.027 | 0.035 | 0.039 | 0.039 |
| Vanadium | | | | | | | | | | | | |
| Total | 0.018 | 0.029 | 0.026 | 0.013 | 0.030 | 0.032 | 0.023 | ND | ND | 0.024 | 0.006 | 0.006 |
| Dissolved | 0.004 | 0.029 | 0.034 | 0.003 | 0.026 | 0.003 | 0.057 | ND | ND | 0.067 | ND | ND |

Notes:

(a) Sampled only in April 1993.

NA = not analyzed.

ND = not detected/below detection limit.

Reference:

Means for RI data calculated from four rounds of sampling: July and October 1992, and February and April 1993. Samples with results reported as below detection not used in calculation of individual station means. Station mean reported as ND if all sample results below detection.

Table 4.5-6
Mean Concentrations of Metals Present in Surface Water for River Sampling Stations Studied from 1992 through 1993

| Parameter (units in mg/l) | All River Samples | Losing-Reach River Station Means | | | | | | | | | | River Station SW17 Mean | Gaining-Reach River Station Means | | | | | | | |
|------------------------------|-------------------------|----------------------------------|-------|-------|-------|-------|-------|-------|---------|-------|---------------|-------------------------------|-----------------------------------|-------|-------|-------|---------|-------|-------|---------------|
| | Mean for 17 stations | SW25 | SW24 | SW23 | SW22 | SW21 | SW20 | SW19 | SW18(a) | SW16 | Group Mean | SW17 | SW12E(b) | SW12 | SW10 | SW08 | SW7E(b) | SW03 | SW01 | Group Mean |
| Aluminum | | | | | | | | | | | | | | | | | | | | |
| Total (4 events) | 0.73 | 0.35 | 0.49 | 0.66 | 0.85 | 0.83 | 0.44 | 0.51 | 0.07 | 0.53 | 0.52 | 1.02 | 1.80 | 0.50 | 0.59 | 0.76 | 1.32 | 1.07 | 0.57 | 0.94 |
| Total (3 events) | 0.18 | 0.17 | 0.16 | 0.22 | 0.30 | 0.30 | 0.12 | 0.17 | 0.07 | 0.13 | 0.18 | ND | NS | 0.10 | 0.17 | 0.44 | NS | ND | 0.02 | 0.18 |
| Total (Apr-93) | 1.27 | 0.90 | 1.47 | 1.55 | 1.40 | 1.36 | 1.08 | 1.54 | NS | 1.73 | 1.38 | 1.02 | 1.80 | 0.90 | 1.00 | 1.09 | 1.32 | 1.07 | 1.13 | 1.19 |
| Dissolved | 0.11 | ND | 0.08 | ND | 0.02 | ND | ND | 0.20 | ND | 0.10 | 0.10 | ND | ND | 0.10 | 0.15 | 0.16 | ND | ND | 0.03 | 0.11 |
| Arsenic | | | | | | | | | | | | | | | | | | | | |
| Total | 0.005 | 0.004 | 0.005 | 0.004 | 0.006 | 0.005 | 0.007 | 0.007 | 0.007 | 0.007 | 0.006 | 0.006 | 0.005 | 0.005 | 0.003 | 0.003 | 0.003 | 0.006 | 0.005 | 0.004 |
| Dissolved | 0.004 | 0.004 | 0.004 | 0.003 | 0.003 | 0.003 | 0.006 | 0.003 | ND | 0.003 | 0.004 | 0.003 | 0.005 | 0.006 | 0.004 | 0.006 | 0.004 | 0.003 | 0.003 | 0.004 |
| Barium | | | | | | | | | | | | | | | | | | | | |
| Total | 0.101 | 0.104 | 0.101 | 0.103 | 0.100 | 0.099 | 0.102 | 0.104 | 0.109 | 0.090 | 0.101 | 0.081 | 0.096 | 0.124 | 0.119 | 0.116 | 0.093 | 0.090 | 0.092 | 0.104 |
| Dissolved | 0.096 | 0.092 | 0.094 | 0.094 | 0.093 | 0.088 | 0.099 | 0.104 | 0.108 | 0.095 | 0.096 | 0.096 | 0.076 | 0.096 | 0.100 | 0.102 | 0.078 | 0.082 | 0.137 | 0.096 |
| Boron | | | | | | | | | | | | | | | | | | | | |
| Total | 0.20 | 0.33 | 0.22 | 0.23 | 0.12 | 0.11 | 0.13 | 0.25 | 0.12 | 0.19 | 0.19 | 0.38 | ND | 0.27 | 0.19 | 0.18 | ND | 0.14 | 0.16 | 0.19 |
| Dissolved | 0.18 | 0.17 | 0.31 | 0.14 | 0.15 | 0.18 | 0.16 | 0.20 | 0.13 | 0.19 | 0.18 | 0.23 | ND | 0.20 | 0.20 | 0.17 | ND | 0.14 | 0.15 | 0.17 |
| Copper | | | | | | | | | | | | | | | | | | | | |
| Total | 0.007 | 0.009 | 0.003 | ND | ND | ND | ND | ND | ND | 0.005 | 0.006 | 0.015 | ND | 0.007 | ND | ND | ND | 0.003 | ND | ND |
| Dissolved | 0.007 | 0.003 | 0.003 | ND | 0.003 | ND | ND | 0.022 | ND | 0.005 | 0.007 | 0.011 | ND | 0.003 | 0.004 | 0.004 | ND | 0.012 | ND | 0.006 |
| Iron | | | | | | | | | | | | | | | | | | | | |
| Total (4 events) | 0.56 | 0.50 | 0.54 | 0.63 | 0.43 | 0.54 | 0.33 | 0.61 | 0.07 | 0.54 | 0.47 | 0.41 | 1.73 | 0.38 | 0.31 | 0.34 | 1.32 | 0.42 | 0.40 | 0.70 |
| Total (3 events) | 0.10 | 0.06 | 0.09 | 0.14 | 0.12 | 0.15 | 0.15 | 0.13 | 0.07 | 0.18 | 0.12 | 0.09 | NS | 0.08 | 0.07 | 0.11 | NS | 0.04 | 0.04 | 0.07 |
| Total (Apr-93) | 1.28 | 0.94 | 1.46 | 1.61 | 1.37 | 1.34 | 1.13 | 1.56 | NS | 1.61 | 1.38 | 1.05 | 1.73 | 0.97 | 1.03 | 1.03 | 1.32 | 1.17 | 1.13 | 1.20 |
| Dissolved | 0.05 | 0.06 | 0.09 | ND | 0.02 | 0.09 | 0.02 | 0.05 | ND | 0.03 | 0.05 | 0.09 | ND | 0.06 | 0.05 | 0.04 | ND | 0.04 | 0.04 | 0.05 |

Table 4.5-6 (Cont'd)

| Parameter (units in mg/l) | All River Samples | Losing-Reach River Station Means | | | | | | | | | | River Station SW17 Mean | Gaining-Reach River Station Means | | | | | | | |
|------------------------------|-------------------------|----------------------------------|-------|-------|-------|-------|-------|-------|---------------------|-------|---------------|-------------------------------|-----------------------------------|-------|-------|-------|---------------------|-------|-------|---------------|
| | Mean for 17 stations | SW25 | SW24 | SW23 | SW22 | SW21 | SW20 | SW19 | SW18 ^(a) | SW16 | Group Mean | SW17 | SW12E ^(b) | SW12 | SW10 | SW08 | SW7E ^(b) | SW03 | SW01 | Group Mean |
| Lithium | | | | | | | | | | | | | | | | | | | | |
| Total | 0.048 | 0.058 | 0.058 | 0.055 | 0.052 | 0.057 | 0.053 | 0.051 | 0.056 | 0.049 | 0.054 | 0.049 | 0.023 | 0.039 | 0.041 | 0.037 | ND | 0.039 | 0.043 | 0.037 |
| Dissolved | 0.048 | 0.058 | 0.057 | 0.056 | 0.046 | 0.043 | 0.054 | 0.090 | 0.056 | 0.041 | 0.056 | 0.042 | ND | 0.045 | 0.041 | 0.037 | 0.021 | 0.041 | 0.038 | 0.037 |
| Manganese | | | | | | | | | | | | | | | | | | | | |
| Total | 0.024 | 0.020 | 0.023 | 0.025 | 0.021 | 0.027 | 0.020 | 0.027 | 0.008 | 0.024 | 0.022 | 0.023 | 0.057 | 0.018 | 0.018 | 0.017 | 0.046 | 0.019 | 0.016 | 0.027 |
| Dissolved | 0.008 | 0.004 | 0.032 | ND | 0.002 | ND | 0.004 | 0.035 | ND | 0.004 | 0.013 | 0.005 | 0.001 | 0.005 | 0.004 | 0.004 | 0.001 | 0.002 | 0.004 | 0.003 |
| Vanadium | | | | | | | | | | | | | | | | | | | | |
| Total | 0.016 | 0.013 | 0.005 | 0.012 | 0.003 | 0.022 | 0.004 | ND | 0.004 | 0.037 | 0.013 | 0.027 | ND | 0.019 | 0.023 | 0.031 | ND | 0.005 | 0.017 | 0.019 |
| Dissolved | 0.034 | ND | ND | ND | ND | ND | 0.002 | 0.016 | ND | 0.057 | 0.025 | 0.012 | ND | 0.070 | 0.047 | 0.079 | ND | 0.003 | 0.019 | 0.044 |

Notes:

^(a) SW18 sampled only during October 1992.^(b) Sampled only in April 1993.

NA = not analyzed.

ND = Not detected/below detection limit.

NS = Not sampled.

Reference:

Means for RI data calculated from four rounds of sampling: July and October 1992, and February and April 1993. Samples with results reported as below detection not used in calculation of individual station means. Station mean reported as ND if all sample results below detection. Group mean reported as ND if 70 percent (All River and Losing Reach) to 60 percent (Gaining Reach) of station means below detection limits.

Table 4.5-7
Representative Concentrations for Metals in Surface Water

| Parameter (mg/l) | IDL | Representative Groundwater Concentrations (Mean plus 2XSD; mg/l) | |
|------------------|---------|---|---|
| | | Low-Chloride Bannock Range ^(b) | Portneuf River Valley ^(b) |
| Aluminum | 0.02 | 0.54 | 0.9 |
| Antimony | 0.05 | 0.23 | 0.1 |
| Arsenic | 0.001 | 0.021 | 0.009 |
| Barium | 0.002 | 0.16 | 0.19 |
| Beryllium | 0.0002 | 0.002 | 0.004 |
| Boron | 0.007 | 0.39 | 0.37 |
| Cadmium | 0.0003 | 0.006 | 0.002 |
| Chromium | 0.0001 | 0.008 | 0.015 |
| Cobalt | 0.003 | 0.01 | 0.021 |
| Copper | 0.003 | 0.027 | 0.036 |
| Iron | 0.06 | 0.86 | 1.2 |
| Lead | 0.0005 | 0.008 | 0.008 |
| Lithium | 0.002 | 0.013 | 0.043 |
| Manganese | 0.0007 | 0.047 | ND |
| Mercury | 0.00006 | 0.0011 | 0.0013 |
| Molybdenum | 0.01 | 0.02 | 0.08 |
| Nickel | 0.01 | 0.01 | ND |
| Selenium | 0.002 | 0.005 | 0.005 |
| Silver | 0.004 | 0.01 | 0.003 |
| Thallium | 0.001 | 0.040 | ND |
| Vanadium | 0.002 | 0.103 | 0.331 |
| Zinc | 0.002 | 0.794 | 0.269 |

Notes:

(a) Surface water quality criteria value will be adjusted to compensate for water hardness.

(b) Hydrogeochemical regime.

IDL = Instrument Detection Limit.

ND = Not detected below detection limit.

Table 4.5-8
Metals Not Present in Surface Water within the EMF Study Area

| Parameter (mg/l) | Springs and Spring Drainage | | | | | River Stations | | | | | Representative Concentrations In Groundwater | | | | | |
|--|-----------------------------|-----------|--------|--------|-----|------------------------|-----------|--------|--------|-----|--|-----------------|------------------------------|------------------|---------------------------------|-----------------|
| | Number of Analyses: 46 | | | | | Number of Analyses: 46 | | | | | Bannock Range Regime Low-chloride Subgroup | | Portneuf River Valley Regime | | Representative Wells (16 wells) | |
| | Mean | (±SD) | Min. | Max. | NOS | Mean | (±SD) | Min. | Max. | NOS | Mean | Range (2xSD) | Mean | Range (2XSD) | Mean | Range (2XSD) |
| Generally Not Detected in Spring or River Water | | | | | | | | | | | | | | | | |
| Antimony | 0.301 | (±0.390) | 0.052 | 0.750 | 3 | 0.089 | (±0.058) | 0.048 | 0.130 | 2 | 0.14 | 0.04 to 0.23 | 0.09 | 0.062 to 0.114 | 0.12 | 0.04 to 0.20 |
| Beryllium | 0.017 | (±0.008) | 0.006 | 0.025 | 4 | 0.020 | (±0.013) | 0.002 | 0.032 | 4 | 0.002 | 0.002 to 0.002 | 0.00 | 0.001 to 0.002 | 0.002 | 0.0007 to 0.003 |
| Cadmium | 0.001 | (±0.0005) | 0.0002 | 0.002 | 7 | 0.001 | (±0.001) | 0.0003 | 0.002 | 6 | 0.003 | ND to 0.006 | 0.00 | 0.000 to 0.009 | 0.003 | 0.001 to 0.006 |
| Cobalt | 0.004 | (±0.001) | 0.003 | 0.004 | 2 | 0.006 | (±0.002) | 0.004 | 0.009 | 4 | 0.010 | ND to 0.010 | 0.02 | 0.003 to 0.139 | 0.018 | 0.002 to 0.033 |
| Lead | 0.007 | (±0.008) | 0.001 | 0.016 | 3 | 0.004 | (±0.007) | 0.001 | 0.032 | 17 | 0.003 | ND to 0.008 | 0.01 | 0.002 to 0.016 | 0.002 | ND to 0.006 |
| Mercury | 0.0002 | (±0.0001) | 0.0001 | 0.0004 | 13 | 0.0002 | (±0.0001) | 0.0001 | 0.0004 | 17 | 0.0004 | ND to 0.0011 | 0.0008 | 0.0001 to 0.0043 | 0.0006 | ND to 0.0013 |
| Molybdenum | 0.01 | | 0.01 | 0.01 | 1 | 0.02 | | 0.02 | 0.02 | 1 | 0.02 | ND to 0.02 | 0.03 | 0.013 to 0.072 | 0.03 | ND to 0.07 |
| Nickel | 0.01 | | 0.01 | 0.01 | 1 | 0.02 | (±0.01) | 0.01 | 0.03 | 4 | 0.01 | ND to 0.01 | 0.03 | 0.010 to 0.076 | 0.01 | 0.01 to 0.01 |
| Selenium | 0.003 | (±0.002) | 0.001 | 0.010 | 13 | 0.003 | (±0.001) | 0.001 | 0.005 | 14 | 0.002 | 0.0002 to 0.005 | 0.03 | 0.001 to 0.534 | 0.003 | ND to 0.007 |
| Silver | 0.004 | (±0.001) | 0.003 | 0.004 | 6 | 0.003 | (±0.001) | 0.002 | 0.004 | 4 | 0.004 | 0.001 to 0.01 | 0.002 | 0.002 to 0.011 | 0.004 | 0.002 to 0.006 |
| Thallium | 0.001 | | 0.001 | 0.001 | 1 | ND | | ND | ND | 0 | 0.040 | ND to 0.040 | 0.001 | 0.001 to 0.002 | 0.040 | 0.040 to 0.040 |
| Zinc | 0.03 | (±0.02) | 0.004 | 0.10 | 16 | 0.04 | (±0.01) | 0.02 | 0.07 | 24 | 0.166 | ND to 0.794 | 0.03 | 0.004 to 0.110 | 0.059 | ND to 0.397 |
| Generally Not Detected in Spring Water | | | | | | | | | | | | | | | | |
| Aluminum | 0.24 | (±0.32) | 0.03 | 1.07 | 10 | | | | | | 0.16 | ND to 0.54 | 2.53 | 0.018 to 32.652 | 0.18 | ND to 0.68 |
| Copper | 0.004 | (±0.001) | 0.003 | 0.005 | 3 | | | | | | 0.008 | ND to 0.027 | 0.01 | 0.002 to 0.041 | 0.007 | ND to 0.022 |
| Iron | 0.11 | (±0.24) | 0.01 | 1.22 | 24 | | | | | | 0.19 | ND to 0.86 | 0.91 | 0.010 to 28.932 | 0.21 | ND to 1.1 |
| Manganese | 0.01 | (±0.01) | 0.00 | 0.05 | 16 | | | | | | 0.011 | ND to 0.047 | 1.65 | 0.000 to 91.200 | 0.015 | ND to 0.078 |
| Detected Only at Concentrations Near Detection Limit in Spring and River Water | | | | | | | | | | | | | | | | |
| Chromium | 0.002 | (±0.001) | 0.0001 | 0.004 | 31 | 0.001 | (±0.001) | 0.0002 | 0.004 | 30 | 0.003 | ND to 0.008 | 0.00 | 0.000 to 0.022 | 0.005 | ND to 0.012 |

Notes:

ND = Not detected/below detection limit.

NOS = Number of samples in which parameter detected and number of samples used to calculate statistics.

(a) SD = Standard Deviation; 2XSD range is mean \pm two times SD.

Table 4.5-9
Activities of Radiological Parameters for Springs Studied from 1992 through 1993

| Parameter (pCi/l) | Spring Group | | | | | | | | | | | |
|----------------------|--------------------|--------------------------|--------------------------|------------------------|-----------------------------|---------------------|--------------------------|-----------------------------------|---------------------------|--------------------|-----------------------|-----------|
| | I - Batiste System | | II - Swanson Road System | III - East Side System | | IV - Papoose System | | | | | | |
| | Batiste Spring | Batiste Springs Drainage | Swanson Road Spring | Springs near STP | Spring-fed Pond at FMC Park | Papoose Spring | Papoose Springs Drainage | Papoose Springs Drainage Channels | Papoose Springs Discharge | Siphon Road Spring | Twenty Springs (East) | |
| | SW14 | SW11 | SW15 | SW13 | SW09 | SW07 | SW08 | SW05F | SW05E | SW05 | SW04 | SW02 |
| Gross alpha | | | | | | | | | | | | |
| Jul-92 | 2.30±1.50 | 2.20±1.40 | ND | ND | 2.60±1.60 | 2.00±1.30 | 2.10±1.30 | NA | NA | ND | ND | ND |
| Oct-92 | 2.22±0.50 | 2.31±0.50 | ND | 2.66±0.57 | 2.66±0.50 | ND | ND | NA | NA | ND | ND | ND |
| Feb-93 | 2.97±1.67 | 2.32±1.89 | 3.51±1.62 | 2.86±1.54 | 5.55±1.73 | ND | ND | NA | NA | 2.73±1.64 | ND | 3.26±1.71 |
| Apr-93 | ND | 3.50±1.17 | 2.21±0.91 | 2.90±1.27 | 3.11±0.93 | 8.84±2.30 | 6.58±1.51 | 2.00±1.45 | 2.06±0.84 | 2.06±1.15 | ND | ND |
| Gross beta | | | | | | | | | | | | |
| Jul-92 | 6.10±1.70 | 5.50±1.70 | 8.00±1.80 | 7.10±1.50 | 7.30±1.80 | 4.20±1.60 | 3.90±1.60 | NA | NA | 4.40±1.60 | 3.30±1.50 | 4.90±1.60 |
| Oct-92 | 7.63±0.63 | 5.56±0.58 | 6.10±1.70 | 6.42±0.58 | 5.63±0.52 | 3.20±1.70 | 2.70±1.50 | NA | NA | 5.50±1.90 | 2.80±1.60 | 4.60±1.80 |
| Feb-93 | 6.41±1.00 | 4.98±1.11 | 7.37±1.18 | 5.14±1.15 | 7.10±1.01 | 3.11±0.98 | 2.89±0.97 | NA | NA | 4.83±1.17 | 3.39±0.87 | 2.83±0.83 |
| Apr-93 | 11.00±3.55 | 7.23±1.46 | 6.90±1.45 | 6.43±1.41 | 5.69±1.33 | ±13.70±4.70 | 20.40±4.59 | 3.96±1.40 | 6.65±1.48 | 7.99±3.47 | 4.92±1.30 | 6.93±3.52 |
| Radium-226 | | | | | | | | | | | | |
| Jul-92 | ND | ND | ND | ND | ND | 1.72±0.25 | ND | NA | NA | ND | ND | ND |
| Oct-92 | ND | 2.60±0.40 | 1.82±0.25 | ND | ND | ND | ND | NA | NA | 5.20±0.26 | ND | ND |
| Feb-93 | ND | ND | 1.50±0.62 | ND | ND | 1.93±0.52 | ND | NA | NA | 1.72±0.58 | ND | ND |
| Apr-93 | ND | ND | ND | ND | ND | 1.40±0.38 | ND | 1.00±0.33 | 1.00±0.08 | ND | ND | ND |
| Radium-228 | | | | | | | | | | | | |
| Jul-92 | ND | ND | 1.3±0.5 | ND | ND | ND | ND | NA | NA | ND | ND | ND |
| Oct-92 | ND | ND | 2.2±1.0 | ND | ND | 1.4±0.9 | 1.7±0.9 | NA | NA | ND | 3.5±0.9 | 3.2±1.0 |
| Feb-93 | ND | ND | ND | 1.4±0.9 | ND | ND | ND | NA | NA | ND | ND | 5.3±1.2 |
| Apr-93 | ND | ND | ND | ND | ND | ND | ND | 2.1±0.8 | 2.8±1.2 | 1.1±0.8 | ND | ND |
| Uranium-233/234 | | | | | | | | | | | | |
| Jul-92 | NA | NA | NA | NA | NA | NA | NA | NA | NA | ND | ND | ND |
| Oct-92 | NA | NA | NA | NA | NA | NA | NA | NA | NA | ND | ND | ND |
| Feb-93 | 1.08±0.27 | ND | ND | 1.67±0.52 | ND | ND | ND | NA | NA | 1.19±0.32 | ND | ND |
| Apr-93 | ND | ND | ND | ND | ND | ND | ND | NA | NA | ND | ND | ND |

Notes:

NA = Not analyzed

ND = Not detected/below detection limit.

NS = Not sampled.

Table 4.5-10
Activities of Radiological Parameters for River Stations Studied from 1992 through 1993

| Parameter (pCi/l) | Losing-Reach River Stations | | | | | | | | | River Station SW17 | | Gaining-Reach River Stations | | | | | |
|----------------------|-----------------------------|-----------|------------|-----------|-----------|------------|-----------|-----------|-----------|-----------------------|-----------|------------------------------|------------|-----------|-----------|-----------|------------|
| | SW25 | SW24 | SW23 | SW22 | SW21 | SW20 | SW19 | SW18 | SW16 | SW17 | SW12E | SW12 | SW10 | SW08 | SW07E | SW03 | SW01 |
| Gross alpha | | | | | | | | | | | | | | | | | |
| Jul-92 | ND | ND | ND | 2.60±1.60 | ND | ND | 2.70±1.70 | NS | 3.00±1.60 | ND | NS | ND | 2.20±1.40 | 2.50±1.50 | NS | 2.50±1.70 | 2.10±1.60 |
| Oct-92 | ND | ND | ND | ND | ND | 2.20±1.06 | 2.70±1.80 | ND | ND | ND | NS | 2.86±0.69 | 2.45±0.63 | 4.27±0.60 | NS | ND | ND |
| Feb-93 | 4.93±2.00 | 2.03±1.52 | 2.60±1.84 | 3.31±1.58 | NS | 3.60±1.96 | 4.34±2.04 | NS | 2.61±1.94 | 3.69±1.54 | NS | 3.78±1.21 | 3.04±1.49 | 3.22±1.34 | NS | 3.60±1.55 | 3.22±1.19 |
| Apr-93 | 2.20±0.94 | ND | 6.55±1.48 | 2.59±1.11 | ND | ND | 2.37±0.90 | NS | ND | ND | 2.53±1.13 | 2.04±1.36 | 10.80±2.10 | 3.09±0.93 | 2.30±1.24 | 2.63±0.87 | 2.87±1.02 |
| Gross beta | | | | | | | | | | | | | | | | | |
| Jul-92 | 8.10±1.30 | 6.90±1.80 | 8.40±1.30 | 9.60±1.30 | 6.60±1.20 | 7.00±1.20 | 9.10±1.30 | NS | 6.90±1.80 | 9.90±1.90 | NS | 7.30±1.80 | 4.00±1.60 | 5.70±1.70 | NS | 6.40±1.80 | 12.00±2.00 |
| Oct-92 | 9.80±1.80 | 7.10±1.70 | 9.30±1.80 | 7.90±1.70 | 9.30±1.80 | 8.78±1.25 | 9.80±1.80 | 9.40±1.80 | 8.40±1.80 | 5.80±1.60 | NS | 9.04±0.67 | 10.70±0.78 | 9.47±0.66 | NS | 6.60±2.00 | 4.20±1.60 |
| Feb-93 | 8.67±1.23 | 9.05±1.24 | 7.08±1.37 | 7.43±1.23 | NS | 8.21±1.42 | 7.89±1.41 | NS | 7.41±1.22 | 7.68±1.15 | NS | 8.05±1.02 | 7.97±1.28 | 7.40±1.02 | NS | 8.80±1.16 | 7.10±0.81 |
| Apr-93 | 5.63±1.67 | 5.15±1.58 | 13.80±4.31 | 9.72±1.79 | ND | 11.10±3.87 | 4.80±1.29 | NS | 5.40±1.37 | 2.40±1.43 | 3.41±1.74 | 10.10±4.64 | 8.71±3.57 | 8.39±1.42 | 5.20±1.45 | 6.80±1.44 | 5.96±1.35 |
| Radium-226 | | | | | | | | | | | | | | | | | |
| Jul-92 | ND | ND | ND | ND | ND | ND | ND | NS | ND | ND | NS | ND | ND | ND | NS | 3.11±0.27 | ND |
| Oct-92 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | NS | ND | ND | ND | NS | ND | ND |
| Feb-93 | ND | 2.91±0.78 | ND | ND | NS | ND | ND | NS | ND | 1.19±0.50 | NS | ND | ND | ND | NS | 1.15±0.49 | ND |
| Apr-93 | 1.31±0.38 | ND | ND | ND | ND | ND | 1.29±0.27 | NS | ND | 1.14±0.36 | 1.00±0.17 | ND | ND | ND | ND | ND | 1.00±0.34 |
| Radium-228 | | | | | | | | | | | | | | | | | |
| Jul-92 | ND | ND | 7.5±0.8 | ND | 1.2±0.5 | 1.9±0.9 | ND | NS | ND | ND | NS | ND | ND | ND | NS | ND | ND |
| Oct-92 | 2.1±1.1 | 2.3±1.0 | 3.2±1.0 | ND | 1.5±0.9 | 1.7±0.9 | 2.0±1.0 | 2.2±1.0 | ND | ND | NS | ND | ND | ND | NS | 5.9±2.2 | 2.1±0.9 |
| Feb-93 | ND | ND | ND | ND | NS | 3.4±0.9 | ND | NS | ND | ND | NS | ND | ND | ND | NS | ND | ND |
| Apr-93 | 3.3±0.8 | ND | 1.6±0.8 | ND | 1.2±0.7 | ND | ND | NS | 1.6±0.8 | ND | 2.0±0.8 | 1.1±0.8 | ND | ND | 1.2±0.9 | 1.8±1.0 | ND |
| Uranium-233/234 | | | | | | | | | | | | | | | | | |
| Jul-92 | NA | NA | NA | NA | NA | NA | NA | NS | NA | NA | NS | NA | ND | NA | NS | NA | NA |
| Oct-92 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NS | NA | ND | NA | NS | NA | NA |
| Feb-93 | 1.26±0.29 | 1.39±0.29 | NA | 1.40±0.35 | NS | NA | NA | NS | NA | 1.12±0.47 | NS | NA | 1.23±0.30 | NA | NS | NA | 1.36±0.51 |
| Apr-93 | NA | NA | NA | NA | NA | NA | NA | NS | NA | NA | NA | NA | ND | NA | NA | NA | NA |

Notes:

NA = Not analyzed.

ND = Not detected/below detection limit.

NS = Not sampled.

Section 4 Nature and Extent of Constituents of Potential Concern

Table 4.5-11
Percentage of Gross Beta Accounted for by Potassium-40

| Station ID | Sampling Round | | | |
|------------|----------------|-------------|--------|--------|
| | Jul-92 | Oct-92 | Feb-93 | Apr-93 |
| 1 | 52.5 | 162.3 | 96.0 | 77.8 |
| 2 | 60.9 | 68.5 | 108.4 | 40.7 |
| 3 | 102.5 | 107.1 | 81.3 | 69.9 |
| 4 | 92.9 | 109.5 | 93.0 | 56.8 |
| 5 | 83.3 | 106.9 | 75.9 | 59.9 |
| 5E | NS | NS | NS | 46.9 |
| 5F | NS | NS | NS | 84.1 |
| 6 | 107.0 | 132.5 | 123.8 | 15.6 |
| 7 | 89.3 | 114.5 | 115.1 | 23.1 |
| 8 | 95.7 | 81.0 | 99.0 | 60.5 |
| 9 | 82.9 | 93.8 | 74.4 | 97.4 |
| 10 | 117.2 | 82.8 | 103.7 | 59.4 |
| 11 | 102.2 | 75.1 | 94.1 | 74.9 |
| 12 | 95.7 | 88.6 | 93.1 | 85.2 |
| 12E | NS | NS | NS | 141.4 |
| 13 | 90.0 | 95.6 | 111.1 | 85.8 |
| 14 | 92.2 | 75.9 | 90.4 | 115.9 |
| 15 | 82.0 | 111.7 | 84.4 | 79.9 |
| 16 | 98.8 | 106.5 | 112.7 | 86.5 |
| 17 | 83.5 | 123.4 | 102.1 | 217.8 |
| 18 | NS | 97.9 | NS | NS |
| 19 | 78.6 | 95.6 | 110.1 | 94.7 |
| 20 | 126.6 | 102.9/106.7 | 103.8 | 39.3 |
| 21 | 118.8 | 100.8 | NS | ND |
| 22 | 82.5 | 115.4 | 113.5 | 45.5 |
| 23 | 109.5 | 98.9 | 121.5 | 32.2 |
| 24 | 125.9 | 127.2 | 92.3 | 86.1 |
| 25 | 126.2 | 94.8 | 99.3 | 79.7 |

Notes:

All results given in %.

ND = Not detected/below detection limit.

NS = Not sampled.

Table 4.5-12
Mean Concentrations of Common Ions, Physical Parameters, and Nutrients and Fluoride for Springs Studied from 1992 through 1993

| Parameter | I - Batiste System | | | II - Swanson Road System | | III - East Side System | | | IV - Papoose System | | | | | | | |
|---|------------------------|------------------------|--------------------------|--------------------------|------------------------|------------------------|------------------------|-----------------------------|------------------------|------------------------|--------------------------|---------------------------------|---------------------------|------------------------|------------------------|----------------|
| | System Mean | Batiste Spring | Batiste Springs Drainage | System Mean | Swanson Road Spring | System Mean | Springs near STP | Spring-fed Pond at FMC Park | System Mean | Papoose Spring | Papoose Springs Drainage | Papoose Spring Drainage Channel | Papoose Springs Discharge | Siphon Road Spring | Twenty Springs (East) | |
| | 1978-80 ^(a) | 1992-93 ^(b) | 1992-93 ^(b) | 1978-80 ^(a) | 1992-93 ^(b) | 1978-80 ^(a) | 1992-93 ^(b) | 1992-93 ^(b) | 1978-80 ^(a) | 1992-93 ^(b) | 1992-93 ^(b) | April 1993 ^(b) | 1992-93 ^(b) | 1992-93 ^(b) | 1992-93 ^(b) | |
| | Perry et al. (1990) | SW14 | SW11 | Perry et al. (1990) | SW15 | Perry et al. (1990) | SW13 | SW09 | Perry et al. (1990) | SW07 | SW06 | SW5E | SW5F | SW05 | SW04 | SW02 |
| Common Ions | | | | | | | | | | | | | | | | |
| Alkalinity, bicarbonate, mg/l | 233.3 | 211 | 222 | 290.2 | 286 | 264.4 | 278 | 357 | 201.1 | 252 | 205 | 190 | 204 | 211 | 181 | 186 |
| Calcium, mg/l | 101.3 | 69.5 (78.7) | 58.0 (64.1) | 79.5 | 92.7 (98.5) | 70.2 | 64.6 (67.9) | 59.7 (63.7) | 60.5 | 57.1 (61.2) | 57.5 (61.4) | 59.4 | 57.8 | 59.0 (63.3) | 54.0 (58.1) | 54.4 (58.4) |
| Chloride, mg/l | 55.7 | 40.2 | 27.9 | 40.3 | 49.3 | 26.8 | 27.5 | 21.7 | 20.9 | 17.9 | 18.8 | 17.0 | 20.0 | 26.5 | 15.2 | 15.5 |
| Magnesium, mg/l | 34.4 | 26.6 | 22.5 | 27.8 | 33.5 | 27 | 27.5 | 25.8 | 21.4 | 20.1 | 19.9 | 19.8 | 20.9 | 22.4 | 16.9 | 16.9 |
| Potassium, mg/l | 9.5 | 8.79 | 5.84 | 6.7 | 7.37 | 6.2 | 6.97 | 6.50 | 5.4 | 4.15 | 4.26 | 3.66 | 3.91 | 5.28 | 3.54 | 3.53 |
| Sodium, mg/l | 53.6 | 52.9 | 42.7 | 41.4 | 55.7 | 36.1 | 54.4 | 37.2 | 23.4 | 23.8 | 23.4 | 21.0 | 23.6 | 31.2 | 20.3 | 20.6 |
| Sulfate, mg/l | ~150 | 113 | 51 | ~40 | 104 | ~55 | 55 | 45 | ~45 | 38 | 39 | 39 | 39 | 43 | 38 | 39 |
| Physical Parameters | | | | | | | | | | | | | | | | |
| Specific conductance, μ mhos | 946.3 | 773 | 609 | 732.5 | 907.7 | 638.5 | 747.0 | 658.5 | 515.7 | 495.7 | 495.7 | 519 | 535 | 565.3 | 469.0 | 458.3 |
| pH, units | | 7.3 | 7.8 | | 7.3 | | 7.3 | 7.5 | | 7.8 | 7.8 | 8.0 | 8.2 | 7.8 | 7.7 | 7.8 |
| Temperature, °C | | 13.9 | 14.4 | | 13.6 | | 17.1 | 17.5 | | 14.3 | 14.6 | 12.4 | 13.4 | 14.0 | 16.3 | 16.4 |
| Total dissolved solids, mg/l | | 465 | 360 | | 540 | | 415 | 350 | | 300 | 293 | 260 | 330 | 320 | 290 | 313 |
| Total suspended solids, mg/l | | ND | 9 | | ND | | 6.0 | 4.0 | | ND | ND | NM | NM | ND | 22.0 | 21.0 |
| Nutrients and Fluoride | | | | | | | | | | | | | | | | |
| Ammonia (NH ₃ as N), mg/l | 6.19 | ND | 0.3 | 0.05 | 0.4 | 0.22 | ND | ND | 0.08 | 0.5 | ND | ND | ND | 0.4 | ND | ND |
| Nitrate (NO ₃ as N), mg/l | 5.58 | 4.44 | 1.99 | 2.54 | 2.64 | 2.1 | 3.41 | 2.30 | 1.43 | 2.98 | 2.14 | 2.47 | 2.56 | 2.15 | 1.40 | 1.47 |
| Orthophosphate (PO ₄ as P), mg/l | 1.9 | 2.36 | 0.59 | 0.04 | 0.99 | 0.1 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | ND | 0.24 | 0.04 | 0.03 |
| Phosphorus, total, mg/l | 2.06 | 2.71 | 0.48 | 0.07 | 1.05 | 0.14 | 0.05 | 0.04 | 0.07 | ND | 0.04 | 0.05 | ND | 0.22 | 0.07 | 0.09 |
| Fluoride, mg/l | 0.44 | 0.6 | 0.6 | 0.3 | 0.5 | 0.42 | 0.3 | 0.4 | 1.32 | 0.5 | 0.6 | 0.6 | 0.5 | 0.5 | 0.8 | 0.7 |
| Dissolved oxygen, mg/l | | 6.5 | 9.9 | | 4.7 | | 8.0 | 9.9 | | 8.0 | 8.9 | 8.2 | 9.4 | 7.5 | 6.5 | 7.7 |

Notes:

(a) Sampling dates.

(b) Sampling date was April 1993. Numbers indicate one round of sampling, not a mean.

ND = not detected/below detection limit.

Reference:

Means for RI data calculated from four rounds of sampling: July and October 1992, and February and April 1993; except calcium value in parentheses calculated from October 1992, February 1993, and April 1993 data only. Samples with results reported as below detection not used in calculation of means. Mean reported as ND if all sample results below detection.

Table 4.5-13
Mean Concentrations of Common Ions, Physical Parameters, and Nutrients and Fluoride for River Sampling Stations Studied from 1992 through 1993

| Parameter | All River Samples (mean for 17 stations) | Losing-Reach River Station Means | | | | | | | | | | River Station SW17 Mean | Gaining-Reach River Station Means | | | | | | | |
|---|---|----------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|----------------|----------------|-------------------------------|-----------------------------------|----------------|----------------|----------------|------|----------------|----------------|----------------|
| | Mean | SW25 | SW24 | SW23 | SW22 | SW21 | SW20 | SW19 | SW18 ^(a) | SW16 | Group Mean | SW17 | SW12E | SW12 | SW10 | SW08 | SW7E | SW03 | SW01 | Group Mean |
| Common Ions | | | | | | | | | | | | | | | | | | | | |
| Alkalinity, bicarbonate, mg/l | 247 | 250 | 253 | 248 | 248 | 231 | 257 | 249 | 284 | 246 | 252 | 188 | 224 | 268 | 251 | 251 | 212 | 246 | 241 | 251 |
| Calcium, mg/l | 63.8 (70.9) | 62.0 (72.3) | 61.6 (71.9) | 62.9 (72.6) | 53.4 (65.2) | 55.8 (65.8) | 65.9 (73.7) | 65.7 (75.0) | 69.8 (69.8) | 65.5 (72.1) | 62.5 (70.9) | 62.2 (67.6) | 69.1 | 70.2 (75.3) | 66.1 (72.9) | 65.5 (70.3) | 63.9 | 66.0 (70.1) | 65.1 (69.1) | 66.6 (71.5) |
| Chloride, mg/l | 46.1 | 46.7 | 48.1 | 47.7 | 45.5 | 42.8 | 46.5 | 45.7 | 56.3 | 46.5 | 47.3 | 54.6 | 32.0 | 49.0 | 43.5 | 38.5 | 33.0 | 40.9 | 39.6 | 42.3 |
| Magnesium, mg/l | 29.9 | 32.4 | 31.1 | 32.2 | 30.6 | 28.9 | 32.7 | 32.0 | 37.2 | 30.5 | 32.0 | 22.6 | 25.3 | 30.6 | 27.9 | 27.4 | 23.5 | 26.8 | 26.1 | 27.8 |
| Potassium, mg/l | 8.67 | 9.57 | 8.95 | 9.23 | 8.77 | 8.50 | 9.43 | 8.73 | 10.80 | 8.45 | 9.16 | 8.36 | 5.66 | 9.12 | 7.92 | 7.49 | 5.62 | 7.50 | 7.21 | 7.85 |
| Sodium, mg/l | 44.7 | 41.0 | 41.6 | 41.7 | 40.2 | 43.5 | 41.5 | 39.7 | 48.1 | 41.1 | 42.1 | 47.7 | 29.8 | 55.1 | 48.6 | 42.7 | 32.3 | 47.1 | 51.2 | 49.0 |
| Sulfate, mg/l | 50.0 | 50 | 38 | 42 | 42 | 38 | 43 | 41 | 46 | 45 | 42.9 | 65 | 41 | 70 | 60 | 54 | 49 | 58 | 57 | 59.8 |
| Physical Parameters | | | | | | | | | | | | | | | | | | | | |
| Specific conductance, μ mhos | 702 | 730.3 | 707.3 | 702.7 | 677.3 | 647.7 | 696.0 | 631.0 | 875.0 | 678.7 | 705 | 738.0 | 614 | 775.7 | 667.3 | 685.3 | 617 | 673.7 | 642.3 | 689 |
| pH, units | 8.2 | 8.5 | 8.4 | 8.4 | 8.4 | 8.5 | 8.7 | 8.3 | 8.6 | 8.2 | 8.5 | 8.5 | 8.0 | 7.5 | 7.7 | 7.9 | 7.9 | 7.6 | 7.7 | 7.7 |
| Temperature, °C | 15.6 | 17.0 | 15.6 | 15.6 | 15.9 | 17.2 | 14.7 | 17.3 | 12.4 | 13.8 | 15.5 | 17.6 | 11.5 | 14.9 | 14.1 | 16.2 | 10.9 | 16.3 | 15.8 | 15.5 |
| Total dissolved solids, mg/l | 394 | 403 | 393 | 380 | 347 | 300 | 405 | 380 | NM | 400 | 376 | 403 | 350 | 460 | 420 | 425 | 340 | 410 | 393 | 422 |
| Total suspended solids, mg/l | 15 | 9.0 | 12.0 | 14.0 | 17.0 | 52.0 | 22.0 | 15.0 | NM | 9.0 | 19 | 5.0 | NM | 6.5 | 6.0 | 28.0 | NM | 4.0 | 4.0 | 10 |
| Nutrients | | | | | | | | | | | | | | | | | | | | |
| Ammonia (NH ₃ as N), mg/l | 1.2 | ND | 0.3 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 3.4 | 1.2 | 0.9 | ND | 0.8 | 0.8 | 1.4 |
| Nitrate (NO ₃ as N), mg/l | 1.13 | 0.64 | 0.68 | 0.59 | 0.65 | 0.42 | 0.60 | 0.66 | 0.31 | 0.82 | 0.60 | 1.29 | 1.23 | 2.09 | 1.91 | 1.93 | 0.82 | 2.14 | 2.26 | 2.07 |
| Orthophosphate (PO ₄ as P), mg/l | 0.24 | 0.03 | 0.03 | 0.05 | 0.03 | 0.03 | 0.03 | 0.03 | ND | 0.07 | 0.04 | 0.32 | 0.34 | 0.97 | 0.45 | 0.39 | 0.38 | 0.48 | 0.45 | 0.55 |
| Phosphorus, total, mg/l | 0.30 | 0.09 | 0.09 | 0.09 | 0.08 | 0.16 | 0.06 | 0.13 | 0.02 | 0.15 | 0.10 | 0.64 | 0.47 | 1.05 | 0.49 | 0.43 | 0.48 | 0.52 | 0.45 | 0.59 |
| Fluoride, mg/l | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.7 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Dissolved oxygen, mg/l | 9.2 | 12.7 | 9.1 | 9.1 | 9.2 | 9.9 | 9.3 | 9.5 | 10.4 | 9.4 | 9.8 | 9.3 | 7.3 | 8.5 | 7.4 | 7.8 | 10.2 | 7.4 | 9.2 | 8.1 |

Notes:

(a) Sampled only in October 1992.

ND = Not detected/below detection limit.

NM = Not measured.

Reference:

Means for RI data calculated from four rounds of sampling: July and October 1992, and February and April 1993; except calcium value in parentheses calculated from October 1992, and February and April 1993 data only. Samples with results reported as below detection not used in calculation of means. Mean reported as ND if all sample results below detection.

Table 4.5-14
Concentrations of Metals in Sediments for River Sampling Stations Studied in 1992

| Parameter | Upstream River Stations | | | | | | | | | | | River Station SW17 | Downstream River Stations | | | | | | | | |
|-------------------|-------------------------|----------------|----------------|----------------------|----------------------|----------------------|-------------------------|-----------------------------------|----------------------|--------------------------|----------------------|----------------------|---------------------------|---------------------|----------------|----------------------------------|----------------|----------------------|------------------------------|------------------------------|------------------------------|
| | SD25 (clayey sand) | SD24 (clay) | SD23 (clay) | SDA2 (silty clay) | SDA1 (silty clay) | SD22 (silty clay) | SD21 (silt and sand) | SD20 (sand w/ silt and gravel) | SD19 (silty clay) | SD18 (sand w/ gravel) | SD16 (silty clay) | SD17 (sandy clay) | SD12 (sand) | SD10 (fine sand) | SD08 (loam) | SD03 (loam, sand, and gravel) | SD01 (loam) | SDB1 (silty clay) | SDC1 (silt w/ fine sands) | SDC2 (silt w/ fine sands) | SDC4 (silt w/ fine sands) |
| Aluminum, total | 4850 | 10400 | 11400 | 11200 J | 14600 J | 5230 | 4450 | 2100 | 8560 | 3690 | 9010 | 7830 | 3810 | 2500 | 5200 | 3670 | 4260 | 16200 J | 5320 J | 8760 J | 6790 J |
| Arsenic, total | 4.1 | 4.1 | 3.5 | 5.5 | 5.7 | 3.4 | 3.6 | ND | 2.7 | 8.4 | 3.0 | 3.7 | 3.7 | 2.4 | 9.9 | 3.1 | 4.4 | 6.2 | 6.5 | 4.6 | 6.1 |
| Barium, total | 174 | 122 | 113 | 123 J | 145 J | 112 | 87.3 | 130 | 144 | 109 J | 123 J | 165 J | 108 J | 68.7 J | 95.8 J | 71.7 J | 95.6 J | 183 J | 118 J | 122 J | 106 J |
| Beryllium, total | 0.21 | 0.65 | 0.41 | 0.62 | 0.81 | 0.10 | ND | ND | ND | ND | 0.80 | 0.73 | 1.10 | 0.35 | 1.50 | ND | 0.79 | 0.89 | 0.32 | 0.50 | 0.32 |
| Boron, total | 4.1 | 4.3 | 6 | 12.2 | 13.2 | 5.2 | 3 | 3.5 | 4.6 | 2.5 | 2.7 | 3.3 | 3.2 | 4.0 | 4.9 | 4.2 | 5.7 | 15.2 | ND | 13.1 | 12.6 |
| Cadmium, total | ND | ND | ND | ND | ND | ND | ND | ND | 1.6 | ND | ND | 22.2 | ND | ND | ND | ND | ND | ND | ND | 1 | 0.95 |
| Chromium, total | 9.2 | 18.1 | 19.4 | 17.2 | 18.9 | 10.6 | 12.4 | 5.6 | 22.4 | 9.6 J | 23.8 J | 80.8 J | 8.2 J | 12.1 J | 16.6 J | 12.4 J | 9.7 J | 25.0 | 11.7 | 19.0 | 16.2 |
| Cobalt, total | 5.5 | 4.5 | 5.8 | 5.2 | 6.4 | 3.7 | 4.9 | 4.4 | 4.8 | ND | ND | ND | ND | ND | ND | ND | ND | 6.4 | 3.6 | 4.4 | 3.1 |
| Copper, total | 12.1 | 11.6 | 12.8 | 11.6 | 14.8 | 10.6 | 10.8 | 9.8 | 12.7 | 7.1 J | 30.8 J | 85.9 J | 9.6 J | 4.8 J | 9.2 J | 6.4 J | 8.3 J | 25.5 | 6.3 | 12.9 | 9.7 |
| Iron, total | 7730 | 10400 | 11400 | 10900 J | 14400 J | 7890 | 7850 | 4970 | 8530 | 5270 J | 10100 J | 7770 J | 6090 J | 5130 J | 7020 J | 7280 J | 6530 J | 16100 J | 6010 J | 8910 J | 6920 J |
| Lead, total | 26.0 J | 51.6 J | 71.9 J | 12.1 | 13.9 | 13.8 | 12.8 | 61.0 J | 38.6 J | 12.4 J | 17.6 J | 21.3 J | 9.8 J | 6.7 J | 19.2 J | 9.2 J | 22.9 J | 30.9 | 8.1 | 9.2 | 8.9 |
| Lithium, total | 6.7 | 12.4 | 14.1 | 12.5 J | 15.8 J | 7.2 | 6.0 | 3.7 | 10.6 | 4.5 | 9.2 | 7.2 | 5.0 | 4.0 | 6.7 | 3.8 | 5.7 | 21.8 J | 7.7 J | 12.1 J | 8.3 J |
| Manganese, total | 522 J | 365 J | 216 J | 229 J | 399 J | 277 J | 300 J | 342 J | 237 J | 170 J | 163 J | 1210 J | 425 J | 99.9 J | 97.6 J | 136 J | 120 J | 238 J | 202 J | 161 J | 140 J |
| Mercury, total | ND | ND | ND | ND | 0.55 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | 1.1 | ND | ND | ND |
| Molybdenum, total | ND | ND | ND | ND | ND | ND | 2.5 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Nickel, total | 6.7 | 7.6 | 7.3 | 11.8 | 13.9 | 5.9 | 4.0 | 2.7 | 6.4 | 4.8 | 6.9 | 12.1 | 4.8 | ND | 6.5 | 4.8 | ND | 16.1 | 7.3 | 9.7 | 7.8 |
| Selenium, total | 0.72 | 0.54 | ND | ND | ND | ND | ND | ND | 1.20 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Silver, total | ND | ND | ND | ND | ND | ND | ND | 3.0 | ND | ND | 1.7 | 4 | 2.2 | 1.4 | 1.2 | 0.44 | 2.1 | ND | 1.3 | ND | ND |
| Thallium, total | ND | ND | ND | ND | ND | 0.14 J | ND | 0.17 | 0.18 | 0.30 J | 0.73 J | 0.53 J | 0.14 J | 0.2 J | 0.24 J | R | 0.28 J | ND | ND | ND | ND |
| Vanadium, total | 32.1 | 28.8 | 30.7 | 18.1 | 21.4 | 25.1 | 23.1 | 24.2 | 32.3 | 19.9 | 25.3 | 87.8 | 18.8 | 15.6 | 30.6 | 14.6 | 21.9 | 23.9 | 10.5 | 17.5 | 13.9 |
| Zinc, total | 24.3 | 42.9 | 48.1 | 50.3 J | 55.3 J | 32.7 | 40.1 | ND | 50.3 | ND | 56.9 J | 251.0 J | 27.0 J | 27.4 J | 39.4 J | 31.8 J | 25.6 J | 97.1 J | 30.2 J | 50.1 J | 41.3 J |

Notes:

Units in mg/kg.

J = Estimated value.

ND = Not detected/below detection limit.

R = Rejected value.

Table 4.5-15

Concentrations of Nutrients and Other Parameters in Sediments
for River Sampling Stations Studied in 1992

| Parameter | Upstream River Stations | | | | | | | | | | | River Station SW17 | Downstream River Stations | | | | | | | | |
|--|--------------------------|----------------|----------------|-------------------------|-------------------------|-------------------------|----------------------------|---|-------------------------|-----------------------------|-------------------------|--------------------------|---------------------------|------------------------|----------------|---|----------------|-------------------------|------------------------------------|------------------------------------|------------------------------------|
| | SD25 (clayey sand) | SD24 (clay) | SD23 (clay) | SDA2 (silty clay) | SDA1 (silty clay) | SD22 (silty clay) | SD21 (silt and sand) | SD20 (sand w/ silt and gravel) | SD19 (silty clay) | SD18 (sand w/ gravel) | SD16 (silty clay) | SD17 (sandy clay) | SD12 (sand) | SD10 (fine sand) | SD08 (loam) | SD03 (loam, sand, and gravel) | SD01 (loam) | SDB1 (silty clay) | SDC1 (silt w/ fine sands) | SDC2 (silt w/ fine sands) | SDC4 (silt w/ fine sands) |
| Calcium | NA | NA | NA | 49100 J | 36500 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 69300 J | 166000 J | 88500 J | 93200 J |
| Magnesium | NA | NA | NA | 5020 J | 5510 J | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 8370 J | 5610 J | 5830 J | 4920 J |
| Orthophosphate (PO ₄ as P) | 2.0 | 2.5 | 0.9 | 3.3 | 6.1 | 0.7 | 0.6 | 0.5 | 0.4 | 0.9 | ND | 1.7 | 1.2 | 2.4 | ND | 4.0 | 0.7 | 10.7 | 5.6 | 2.1 | 2.8 |
| Total phosphorus | 158 | 375 | 314 | 521 | 531 | 369 | 231 | 204 | 640 | 471 | 554 | 5340 | 479 | 7150 | 577 | 227 | 1310 | 493 | 1160 | 707 | 1060 |
| Fluoride | 193 | 241 | 1300 | 390 | 460 | 500 | 198 | 149 | 338 | 240 | 273 | 3080 | 189 | 420 | 237 | 220 | 443 | 505 | 550 | 410 | 340 |
| pH | 7.2 | 7.6 | 8.1 | 7.58 | 7.66 | 7.8 | 8.1 | 8.0 | 7.5 | 7.9 | 7.4 | 7.3 | 7.6 | 8.0 | 7.3 | 6.9 | 7.8 | 7.68 | 7.69 | 7.80 | 7.79 |
| Total organic carbon | NA | NA | NA | 7995 | 9729 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 11074 | 8967 | 4495 | 9468 |

Notes:

Units in mg/kg except for pH.

J = Estimated value.

NA = Not analyzed.

Section 4 Nature and Extent of Constituents of Potential Concern

Table 4.5-16
Analytical Results for Phase II Sediment Samples
Taken at FMC Outfall

| Parameter | 17A | 17B | 17C |
|-------------------|--------|--------|--------|
| Aluminum, total | 10700 | 5990 | 4710 |
| Antimony, total | 7.4 U | 6.2 U | 7 U |
| Arsenic, total | 8.6 | 2.7 | 3.9 |
| Barium, total | 801 | 99.8 | 132 |
| Beryllium, total | 1.2 | 0.28 | 0.29 |
| Boron, total | 25.2 | 4.2 | 3.8 |
| Cadmium, total | 104 | 0.91 U | 0.46 U |
| Calcium | 131000 | 102000 | 208000 |
| Chromium, total | 112 | 10.4 | 9.4 |
| Cobalt, total | 25.2 | 4.1 | 4.4 |
| Copper, total | 352 | 6.1 | 4.1 |
| Fluoride | 7760 | 310 | 230 |
| Iron, total | 11800 | 7070 | 6600 |
| Lead, total | 21.7 J | 8.7J | 1.2 J |
| Lithium, total | 10.4 | 5.7 | 4.8 |
| Magnesium | 4700 | 4550 | 4850 |
| Manganese, total | 21500 | 219 | 437 |
| Mercury, total | 0.19 | 0.04 U | 0.17 |
| Molybdenum, total | 2.4 U | 1.8 U | 2 U |
| Nickel, total | 62.3 | 7.2 U | 6.9 U |
| Orthophosphate | 12.6 | 2.15 | 0.76 |
| Total Phosphorus | 15900 | 490 | 190 |
| Potassium | 2310 | 1320 | 1030 |
| Selenium, total | 2 | 0.72 U | 0.76 U |
| Silver, total | 4 U | 0.62 U | 1.7 U |
| Sulfate | 20 U | 20 U | 20 U |
| Thallium, total | 0.82 J | 0.14 J | 0.3 J |
| Vanadium, total | 111 | 4.8 | 0.31 U |
| Zinc, total | 1800 J | 40.7 J | 31.9 J |

Notes:

Concentrations are in mg/kg.

J = Estimated value.

U = Undetected.

Section 4 Nature and Extent of Constituents of Potential Concern

Table 4.5-17
Activities of Radiological Parameters in Sediments for
River Sampling Stations Studied in 1992

| Parameter | Upstream River Stations | | | | | | | | | | | River Station SW17 |
|--------------|-------------------------|----------------|----------------|----------------------|----------------------|----------------------|-------------------------|-----------------------------------|----------------------|--------------------------|----------------------|----------------------|
| | SD25 (clayey sand) | SD24 (clay) | SD23 (clay) | SDA2 (silty clay) | SDA1 (silty clay) | SD22 (silty clay) | SD21 (silt and sand) | SD20 (sand w/ silt and gravel) | SD19 (silty clay) | SD18 (sand w/ gravel) | SD16 (silty clay) | SD17 (sandy clay) |
| Gross alpha | 6.52±0.90 | 12.5±1.3 | 13.6±1.3 | 6.33±2.96 | ND | 6.52±0.98 | 8.44±1.17 | 6.07±0.83 | 12.0±2.3 | 8.94±2.22 | 8.95±2.03 | 29.2±3.6 |
| Gross beta | 10.8±1.2 | 25.3±1.5 | 25.1±1.5 | 13.4±2.8 | 10.2±2.6 | 12.5±1.1 | 13.3±1.1 | 9.24±1.00 | 16.9±2.4 | 14.1±2.6 | 14.9±2.4 | 30.0±3.2 |
| Cesium-137 | ND | 0.139±0.041 | 0.744±0.080 | NA | NA | ND | ND | ND | 0.144±0.046 | ND | 0.111±0.056 | ND |
| Europium-155 | ND | ND | ND | NA | NA | ND | ND | ND | ND | 0.212±0.080 | ND | ND |
| Potassium-40 | 9.96±0.89 | 16.7±1.1 | 18.4±1.3 | 11.7±1.8 | 9.65±1.57 | 8.08±0.67 | 14.4±1.1 | 9.6±0.7 | 13.8±1.0 | 13.2±1.0 | 14.1±1.1 | 10.3±0.8 |

| Parameter | Downstream River Stations | | | | | | | | |
|--------------|---------------------------|---------------------|----------------|----------------------------------|----------------|----------------------|------------------------------|------------------------------|------------------------------|
| | SD12 (sand) | SD10 (fine sand) | SD08 (loam) | SD03 (loam, sand, and gravel) | SD01 (loam) | SDB1 (silty clay) | SDC1 (silt w/ fine sands) | SDC2 (silt w/ fine sands) | SDC4 (silt w/ fine sands) |
| Gross alpha | 9.94±1.89 | 9.63±2.25 | 9.40±1.66 | 10.7±1.9 | 8.73±2.42 | 8.15±3.22 | ND | 6.03±3.57 | ND |
| Gross beta | 15.3±1.9 | 12.7±2.2 | 14.4±1.9 | 16.1±2.2 | 14.3±2.4 | 13.3±2.8 | ND | 13.5±2.9 | 7.3±2.4 |
| Cesium-137 | ND | ND | ND | ND | 0.103±0.032 | NA | NA | NA | NA |
| Europium-155 | ND | ND | ND | ND | ND | NA | NA | NA | NA |
| Potassium-40 | 11.2±0.9 | 8.92±0.71 | 10.8±0.8 | 11.4±0.8 | 12.8±0.9 | 9.58±1.61 | 2.64±1.27 | 5.87±1.05 | 5.79±1.32 |

Notes:

Units in pCi/g.

NA = Not analyzed.

ND = Not detected/below detection level.

NS = Not sampled.

Table 4.5-18
Concentrations of Metals in Sediments for Springs Studied in 1992

| Parameter | Spring Group | | | | | | | | | |
|-------------------|--------------------|--------------------------|--------------------------|------------------------|-----------------------------|-----------------------|--------------------------|---------------------------|--------------------|----------------------|
| | I - Batiste System | | II - Swanson Road System | III - East Side System | | IV - Papoose System | | | | |
| | Batiste Spring | Batiste Springs Drainage | Swanson Road Spring | Springs near STP | Spring-Fed Pond at FMC Park | Papoose Spring | Papoose Springs Drainage | Papoose Springs Discharge | Siphon Road Spring | Twenty Spring (East) |
| | SD14 | SD11 | SD15 | SD13 | SD09 | SD07 | * | SD05 | SD04 | SD02 |
| | (sand and gravel) | (clayey sandy gravel) | (sand w/ silt) | (sand) | (loam) | (clayey sandy gravel) | | (silty clay) | (loam) | (silty clay) |
| Aluminum, total | 8230 | 3350 | 2970 | 2630 | 8600 | 2530 | NS | 6720 | 4150 | 5770 |
| Arsenic, total | 5.1 | ND | 1.7 | 1.5 | 7.6 | 9.1 | NS | 5.1 | 8.2 | 13.8 |
| Barium, total | 324 J | 55.8 J | 85.3 J | 77.9 | 134 J | 52.1 J | NS | 93.5 J | 83.2 J | 86.3 J |
| Beryllium, total | 0.79 | ND | 0.71 | 0.35 | 1.40 | 0.74 | NS | 0.84 | ND | 2.20 |
| Boron, total | 3.7 | 4.1 | 4.0 | 3.4 | 4.6 | 5.6 | NS | 5.9 | 5.0 | ND |
| Cadmium, total | 0.35 | ND | ND | 1.5 | 0.37 | ND | NS | ND | ND | ND |
| Chromium, total | 14.1 J | 13.5 J | 9.0 J | 15.2 | 12.9 J | 11.5 J | NS | 15.1 J | 20.6 J | 54.0 J |
| Cobalt, total | ND | ND | ND | 2.1 | ND | ND | NS | ND | ND | ND |
| Copper, total | 13.0 J | 6.8 J | 8.1 J | 6.8 | 7.8 J | 5.3 J | NS | 9.3 J | 7.5 J | 11.8 J |
| Iron, total | 6850 J | 8524 J | 6620 J | 5530 | 9710 J | 7760 J | NS | 8220 J | 5920 J | 10400 J |
| Lead, total | 29.5 J | 5.9 J | 12.8 J | 24.7 J | 8.7 J | 7.6 J | NS | 50.5 J | 7.3 J | ND |
| Lithium, total | 9.1 | 5.1 | 3.9 | 3.9 | 9.9 | 4.0 | NS | 8.4 | 6.9 | 4.8 |
| Manganese, total | 117 J | 75.1 J | 405 J | 116 J | 281 J | 52 J | NS | 100 J | 56 J | 22.7 J |
| Mercury, total | ND | ND | ND | ND | ND | ND | NS | ND | ND | ND |
| Molybdenum, total | ND | ND | ND | ND | ND | ND | NS | ND | ND | ND |
| Nickel, total | 7.6 | 5.2 | 4.1 | 2.5 | 6.6 | 5.1 | NS | 6.0 | ND | ND |
| Selenium, total | ND | ND | ND | 3.50 | ND | ND | NS | ND | ND | ND |
| Silver, total | 0.20 | 0.60 | 2.1 | ND | 1.1 | 0.17 | NS | 0.75 | 0.47 | ND |
| Thallium, total | R | R | 0.14 J | ND | 0.14 | R | NS | 0.30 J | R | R |
| Vanadium, total | 20.7 | 21.6 | 20.5 | 28.0 | 24.3 | 17.4 | NS | 26.2 | 25.2 | 192 |
| Zinc, total | 18.5 J | 107.0 J | 15.4 J | 23.5 | 27.8 J | 25.1 J | NS | 54.3 J | 31.4 J | 37.4 J |

Notes:

Units in mg/kg.

J = Estimated Value

ND = Not detected/below detection level.

NS = Not sampled.

R = Rejected value.

* = Not assigned.

Table 4.5-19
Concentrations of Nutrients and Other Parameters in Sediments
for Springs Studied in 1992

| Parameter | Spring Group | | | | | | | | | |
|--|---------------------|--------------------------|--------------------------|------------------------|-----------------------------|-------------------------------|--------------------------|---------------------------|--------------------|-----------------------|
| | I - Balliste System | | II - Swanson Road System | III - East Side System | | IV - Papoose System | | | | |
| | Baliste Spring | Baliste Springs Drainage | Swanson Road Spring | Springs near STP | Spring-Fed Pond at FMC Park | Papoose Spring | Papoose Springs Drainage | Papoose Springs Discharge | Siphon Road Spring | Twenty Springs (East) |
| | SD14 | SD11 | SD15 | SD13 | SD09 | SD07 (clayey sandy gravel) | * | SD05 (silty clay) | SD04 (loam) | SD02 (silty clay) |
| Orthophosphate (PO ₄ as P), mg/kg | 3.4 | ND | 4.9 | 1.2 | 2.3 | 0.5 | NS | 0.9 | ND | ND |
| Total phosphorus, mg/kg | 286 | 537 | 955 | 3950 | 393 | 469 | NS | 577 | 387 | 64.5 |
| Fluoride, mg/kg | 89 | 155 | 333 | 800 | 222 | 206 | NS | 265 | 121 | 75.3 |
| pH | 7.2 | 7.8 | 8.0 | 7.9 | 8.2 | 7.4 | NS | 7.4 | 7.5 | 8.5 |

Notes:

Calcium, magnesium, and total organic carbon were not analyzed.

ND = Not detected/ below detection limit.

NS = Not sampled.

* = Not assigned.

Section 4 Nature and Extent of Constituents of Potential Concern

Table 4.5-20
Concentrations of Radiological Parameters in Sediments for Springs Studied in 1992

| Parameter | Spring Group | | | | | | | | | |
|--------------|---------------------------|-------------------------------|--------------------------|------------------------|-----------------------------|-------------------------------|--------------------------|---------------------------|--------------------|-----------------------|
| | I - Batiste System | | II - Swanson Road System | III - East Side System | | IV - Papoose System | | | | |
| | Batiste Spring | Batiste Springs Drainage | Swanson Road Spring | Springs near STP | Spring-Fed Pond at FMC Park | Papoose Spring | Papoose Springs Drainage | Papoose Springs Discharge | Siphon Road Spring | Twenty Springs (East) |
| | SD14 (sand and gravel) | SD11 (clayey sandy gravel) | SD15 (sand w/ silt) | SD13 (sand) | SD09 (loam) | SD07 (clayey sandy gravel) | * | SD05 (silty clay) | SD04 (loam) | SD02 (silty clay) |
| Gross alpha | 19.8±2.5 | 15.2±3.1 | 11.6±2.0 | 14.8±1.4 | 11.1±1.8 | 15.4±2.1 | NS | 13.1±2.1 | 10.0±1.9 | 18.3±2.5 |
| Gross beta | 18.4±1.9 | 18.9±2.8 | 16.1±1.9 | 18.3±1.3 | 19.5±2.1 | 14.7±2.1 | NS | 18.2±2.3 | 15.9±1.9 | 19.7±2.1 |
| Cesium-137 | ND | ND | ND | ND | ND | 0.336±0.065 | NS | 0.377±0.055 | 0.111±0.040 | ND |
| Europium-155 | ND | ND | ND | ND | 0.306±0.077 | ND | NS | 0.49±0.12 | ND | ND |
| Potassium-40 | 12.5±1.0 | 9.77±0.75 | 13.4±1.0 | 9.96±0.79 | 15.1±1.1 | 9.3±1.1 | NS | 13.6±1.1 | 12.0±1.0 | 13.6±1.2 |

Notes:

Units in pCi/g.

NA = Not analyzed.

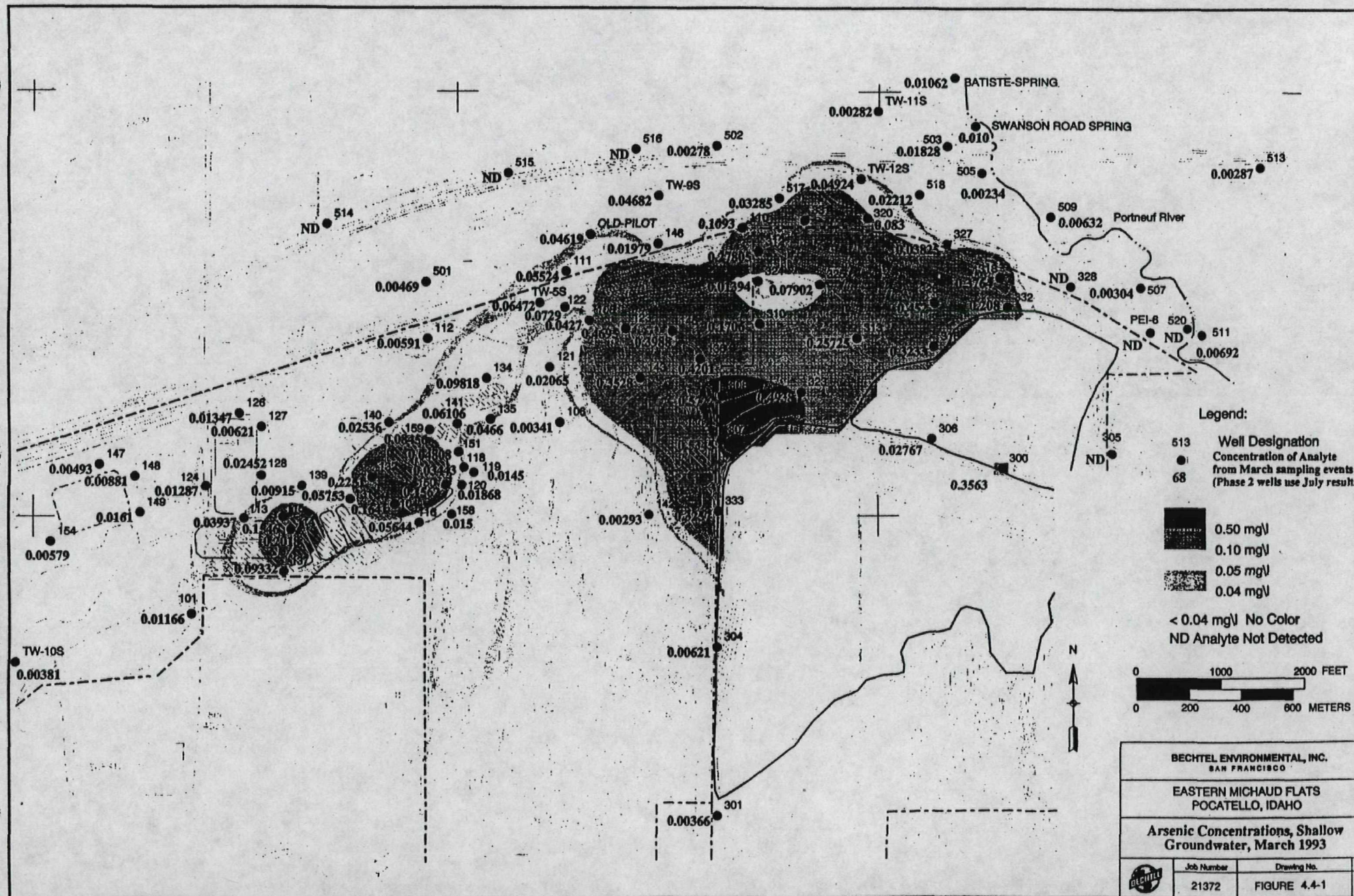
ND = Not detected/below detection level.

NS = Not sampled.

* = Not assigned.

Figures for Section 4.4

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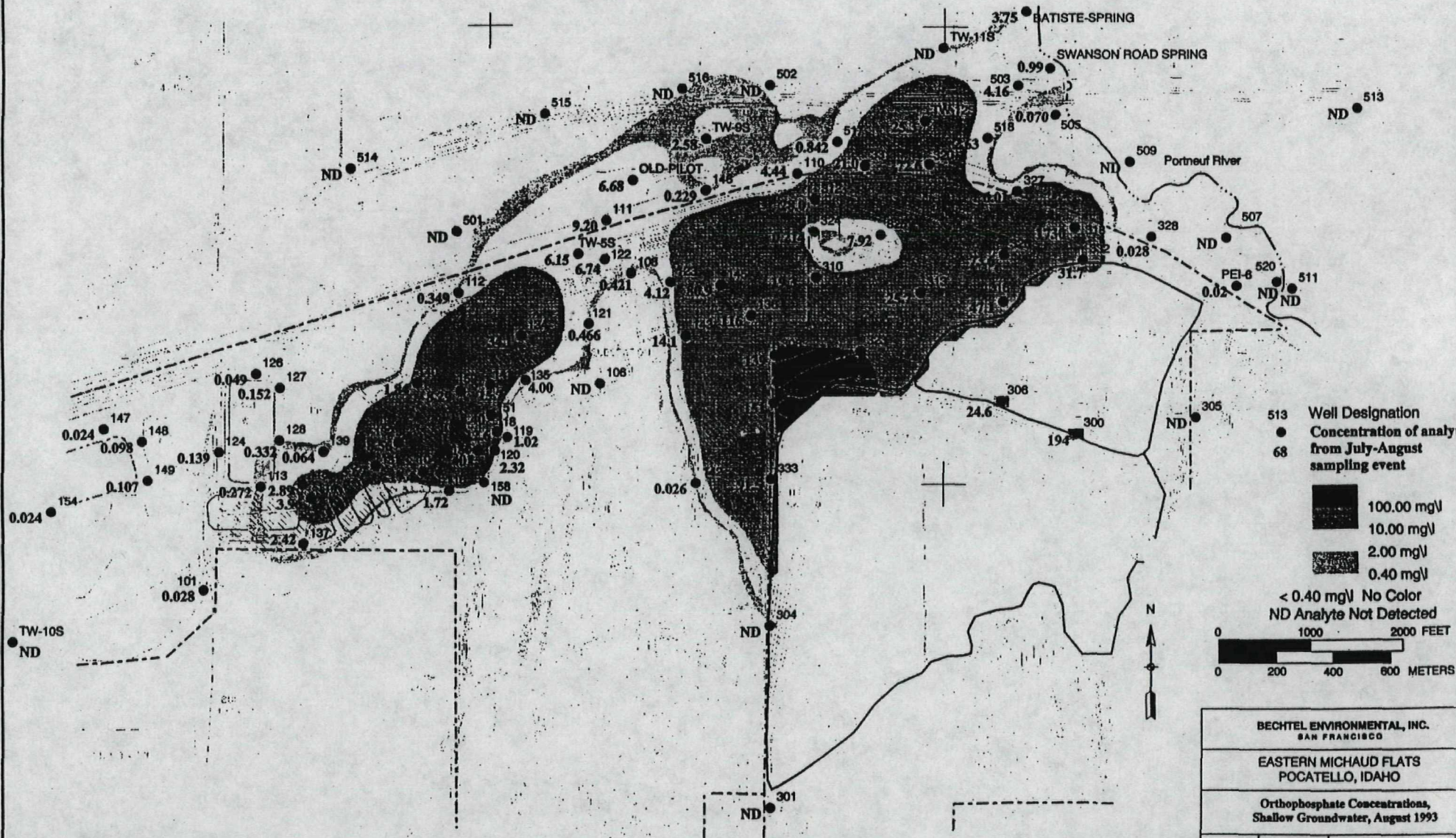
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SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Arsenic Concentrations, Shallow
Groundwater, March 1993



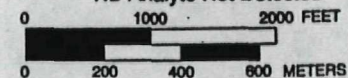
| Job Number | Drawing No. |
|------------|--------------|
| 21372 | FIGURE 4.4-1 |



513 Well Designation
 ● Concentration of analyt
 68 from July-August
 sampling event

100.00 mg/l
10.00 mg/l
2.00 mg/l
0.40 mg/l

< 0.40 mg/l No Color
ND Analyte Not Detected



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**EASTERN MICHAUD FLATS
POCATELLO, IDAHO**

**Orthophosphate Concentrations,
Shallow Groundwater, August 1993**



Job Number

21372

Drawing No.

FIGURE 4.4-2

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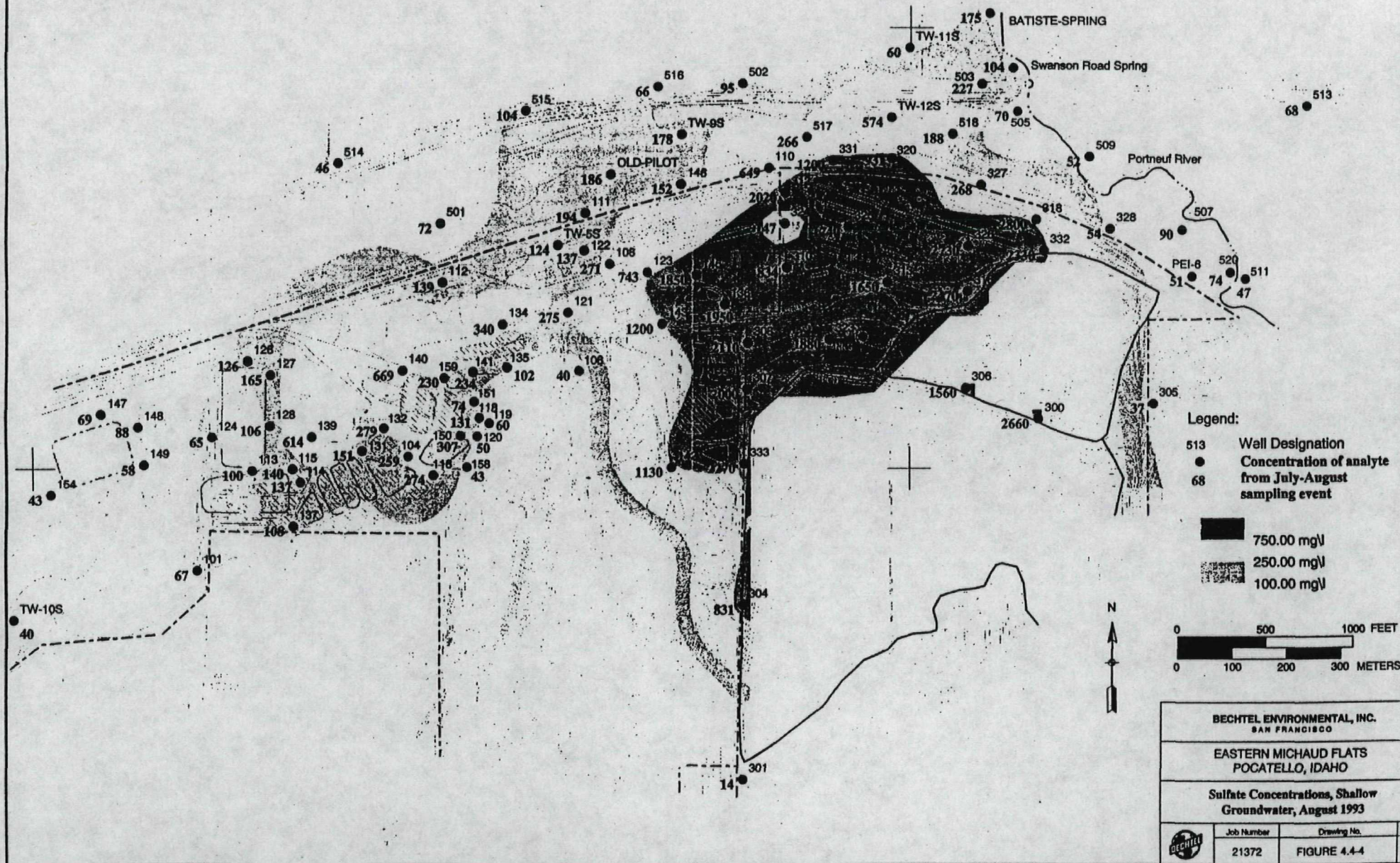
EASTERN MICHAUD FLATS
POCATELLO, IDAHO

pH of Shallow Groundwater,
August 1993

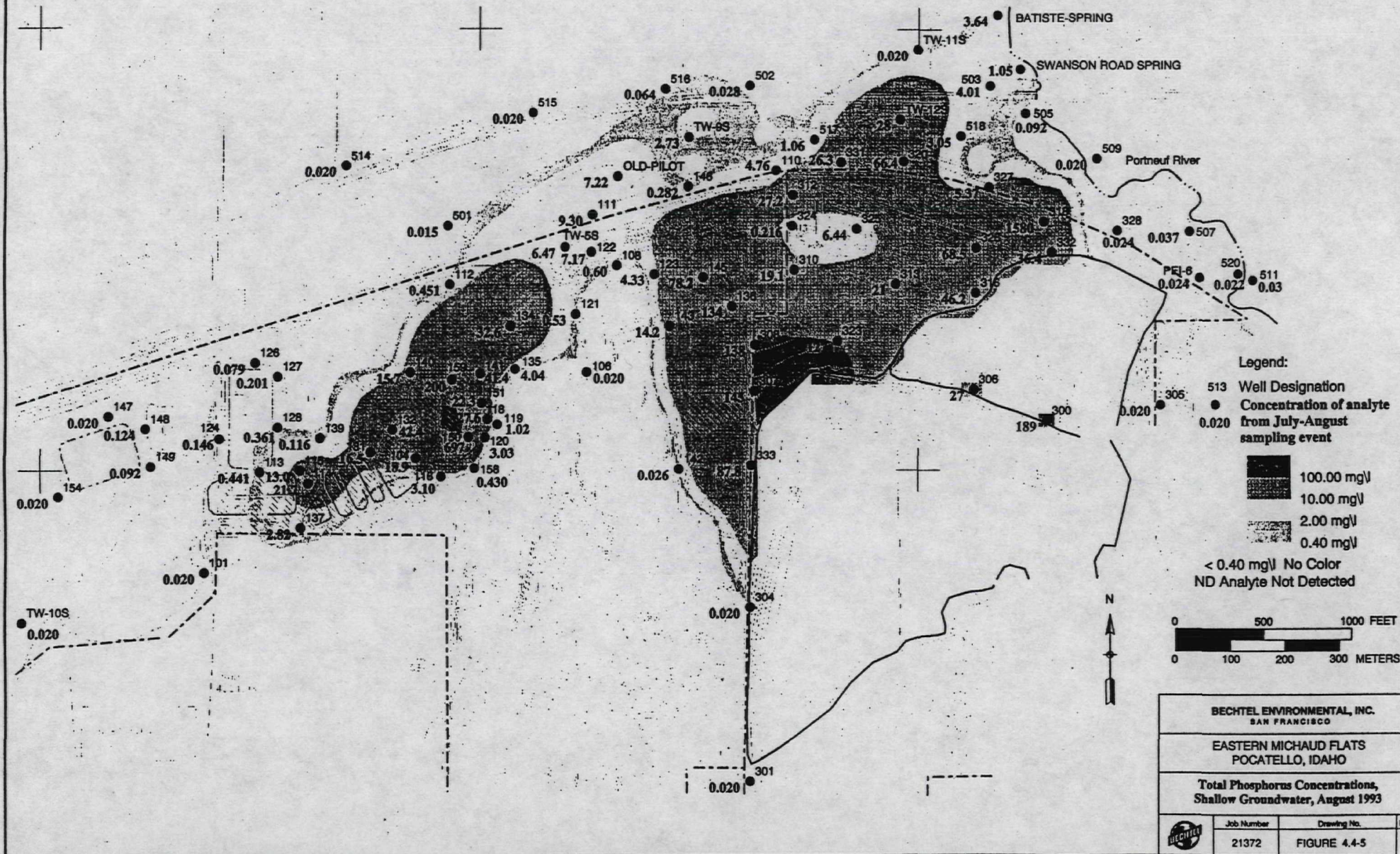


| Job Number | Drawing No. |
|------------|--------------|
| 21372 | FIGURE 4.4-3 |

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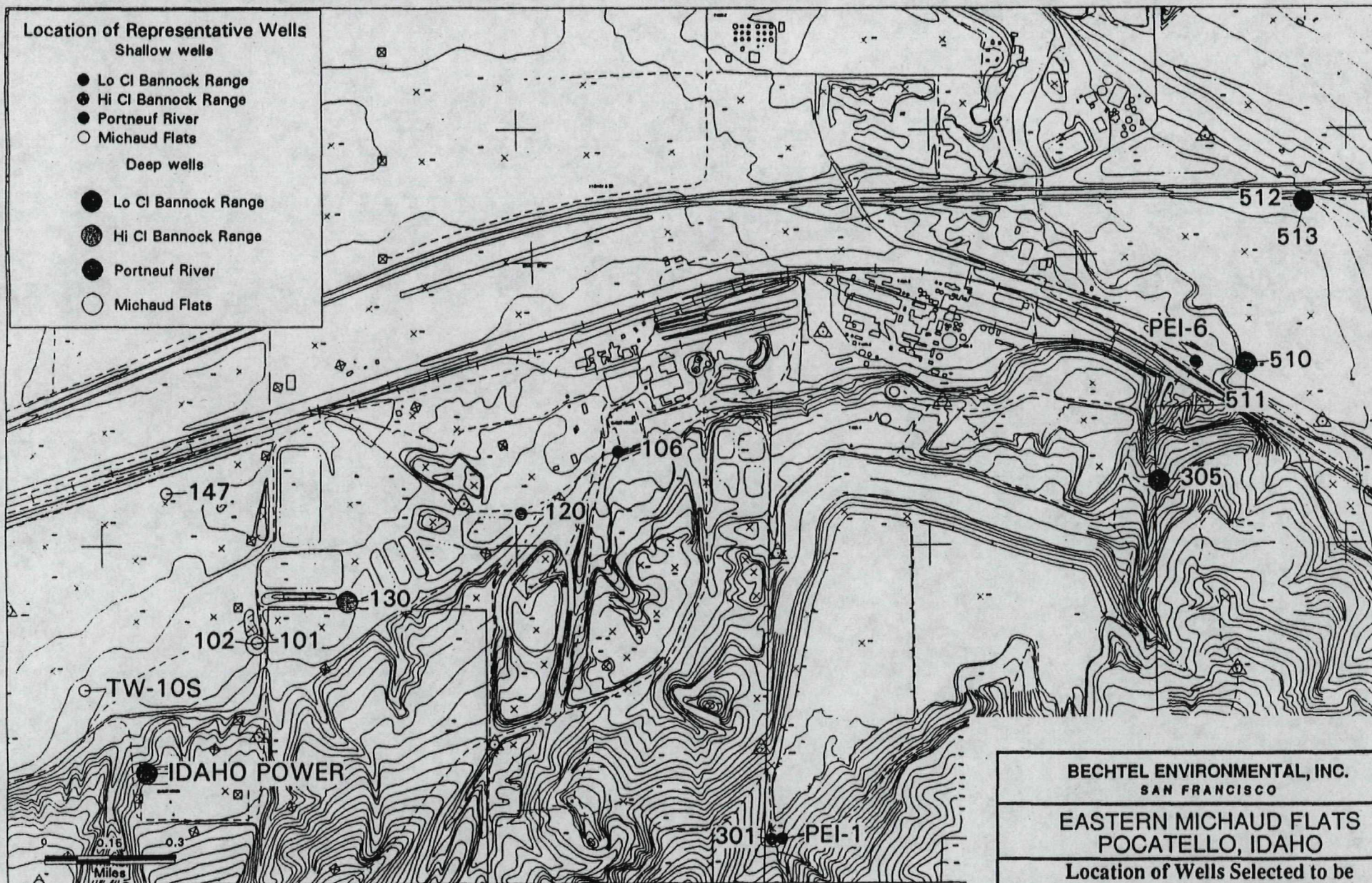
[illegible]

Location of Representative Wells
Shallow wells

- Lo CI Bannock Range
- Hi CI Bannock Range
- Portneuf River
- Michaud Flats

Deep wells

- Lo CI Bannock Range
- Hi CI Bannock Range
- Portneuf River
- Michaud Flats



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Location of Wells Selected to be
Representative of Unimpacted
Groundwater Quality



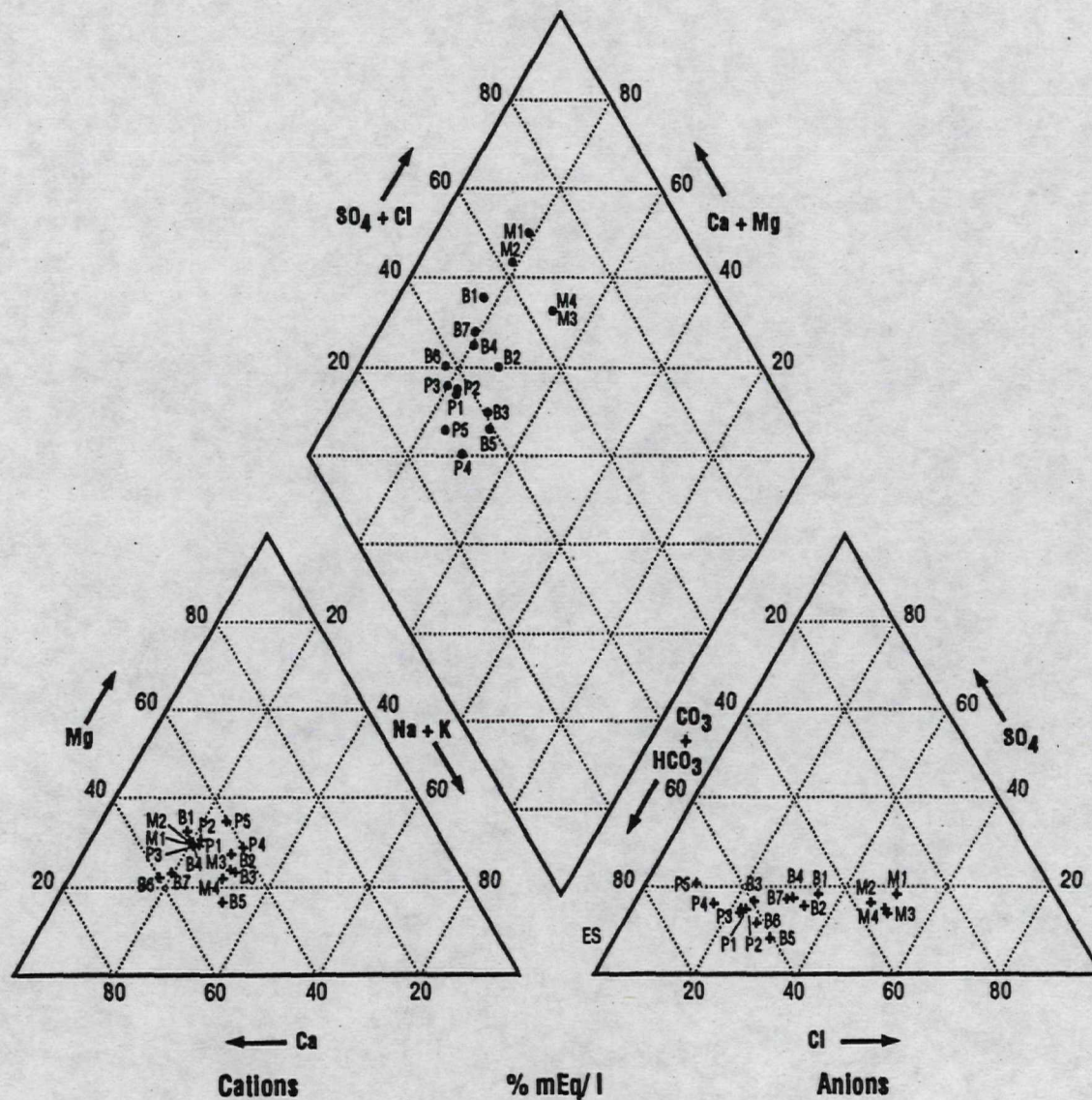
JOB No.

21372

DRAWING NO.

FIGURE 4.4-7

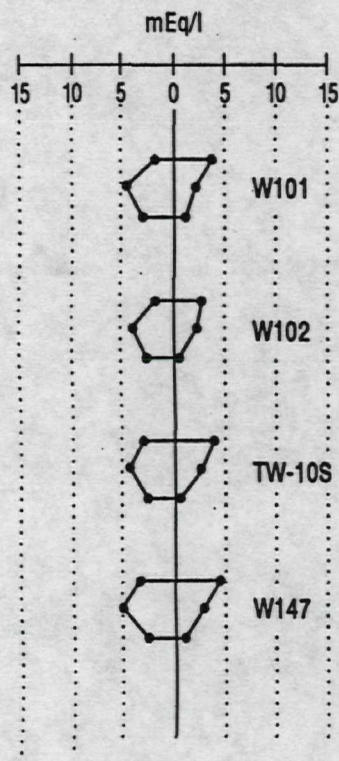
REV.



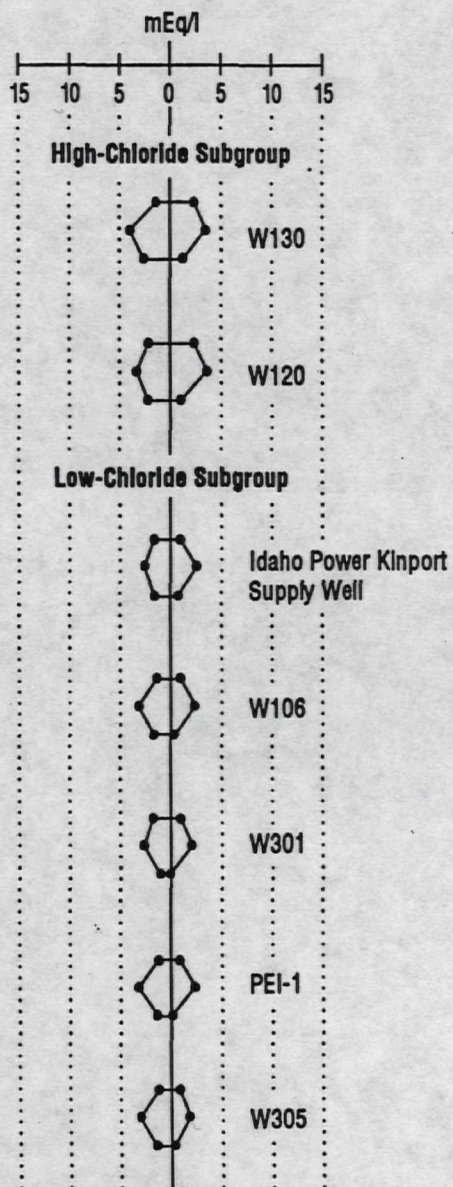
| | | No. | Well |
|-------------------------------------|---------------------------|-----|-------------|
| Michaud Flats Regime | | M1 | 101 |
| | | M2 | 102 |
| | | M3 | TW-10S |
| | | M4 | 147 |
| Bannock Range Regime | High-chloride subgroup | B1 | 130 |
| | | B2 | 120 |
| | Low-chloride subgroup | B3 | Idaho Power |
| | | B4 | 106 |
| | | B5 | 301 |
| | | B6 | PEI-1 |
| | | B7 | 305 |
| Portneuf River Regime | | P1 | PEI-6 |
| | | P2 | 510 |
| | | P3 | 511 |
| | | P4 | 512 |
| | | P5 | 513 |

| | | | |
|--|---------|--------------|------|
| BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO | | | |
| EASTERN MICHAUD FLATS POCATELLO, IDAHO | | | |
| Piper Diagram for Representative Wells | | | |
| | JOB No. | DRAWING NO. | REV. |
| | 21372 | FIGURE 4.4-8 | |

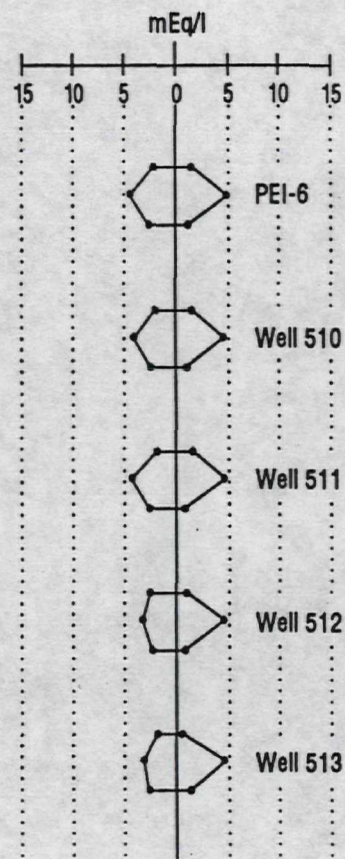
a) Michaud Flats Regime



b) Bannock Range Regime



c) Portneuf River Regime



Legend

| Cations | Anions |
|---------|------------------------------------|
| Na + K | Cl |
| Ca | HCO ₃ + CO ₃ |
| Mg | SO ₄ |

Note: Milliequivalent concentrations calculated from mean ion concentrations for data collected between 10/90 and 6/93.

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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Stiff Diagrams for Representative Wells



JOB No.

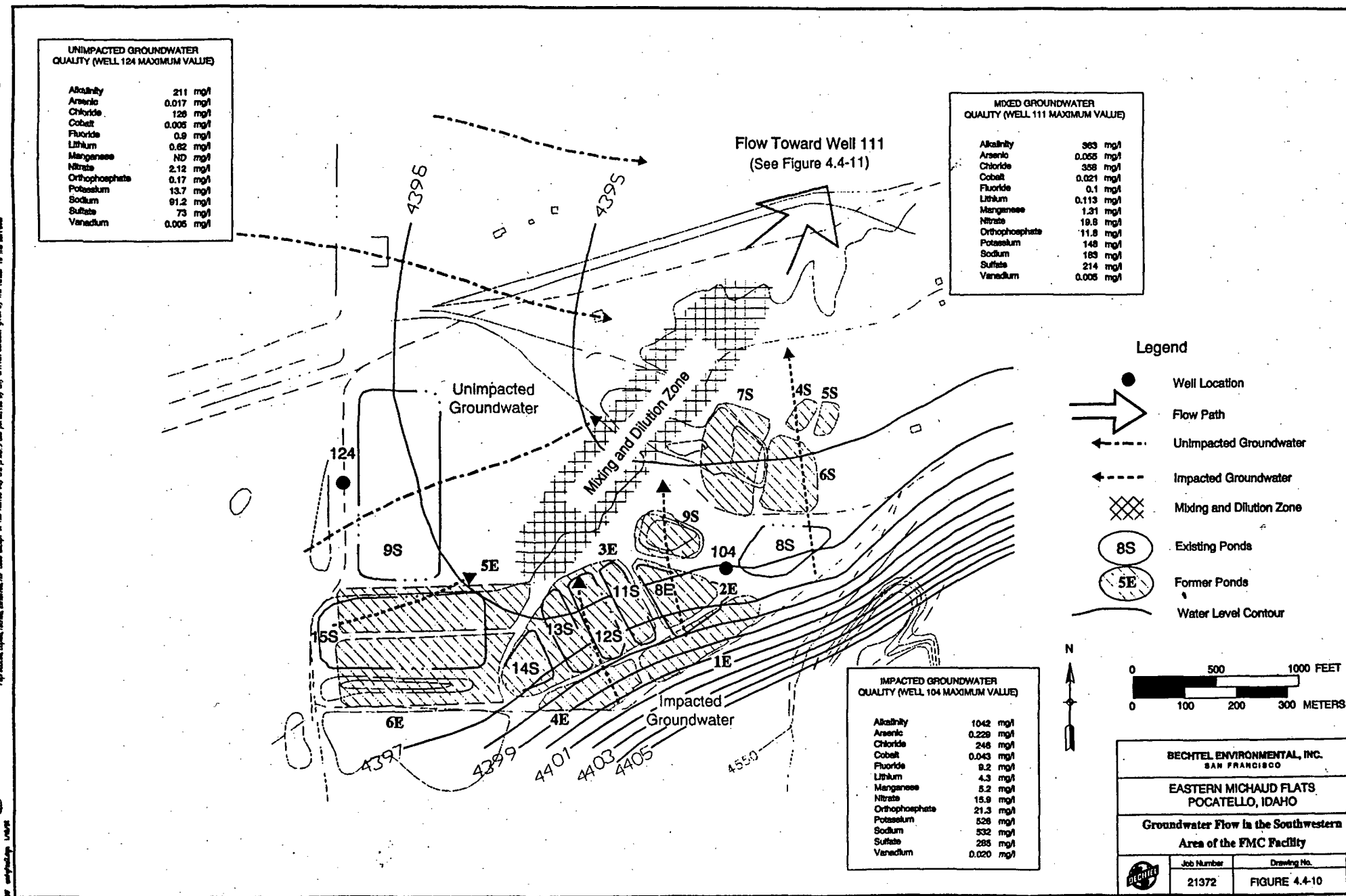
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FIGURE 4.4-9

REV.

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UNIMPACTED GROUNDWATER QUALITY (WELL 112 MAXIMUM VALUE)

| | |
|----------------|------------|
| Alkalinity | 199 mg/l |
| Arsenic | 0.007 mg/l |
| Chloride | 154 mg/l |
| Cobalt | ND mg/l |
| Fluoride | 0.8 mg/l |
| Lithium | 0.099 mg/l |
| Manganese | 0.008 mg/l |
| Nitrate | 5.78 mg/l |
| Orthophosphate | 0.21 mg/l |
| Potassium | 8.4 mg/l |
| Sodium | 63.9 mg/l |
| Sulfate | 106 mg/l |
| Vanadium | 0.003 mg/l |

MIXED GROUNDWATER QUALITY AT FENCELINE (WELL 146 MAXIMUM VALUE)

| | |
|----------------|------------|
| Alkalinity | 282 mg/l |
| Arsenic | 0.037 mg/l |
| Chloride | 143 mg/l |
| Cobalt | 0.008 mg/l |
| Fluoride | 0.8 mg/l |
| Lithium | 0.092 mg/l |
| Manganese | 0.584 mg/l |
| Nitrate | 7 mg/l |
| Orthophosphate | 0.24 mg/l |
| Potassium | 82.4 mg/l |
| Sodium | 71.5 mg/l |
| Sulfate | 138 mg/l |
| Vanadium | 0.010 mg/l |

Legend:

- Well Location
- Flow Path
- Unimpacted Groundwater
- Impacted Groundwater
- ⊗ Mixing and Dilution Zone
- 8S Existing Ponds
- 7S Former Ponds
- Water Level Contours

Note:
Groundwater Quality for Wells 111
and 104 shown on figure 4.4-10



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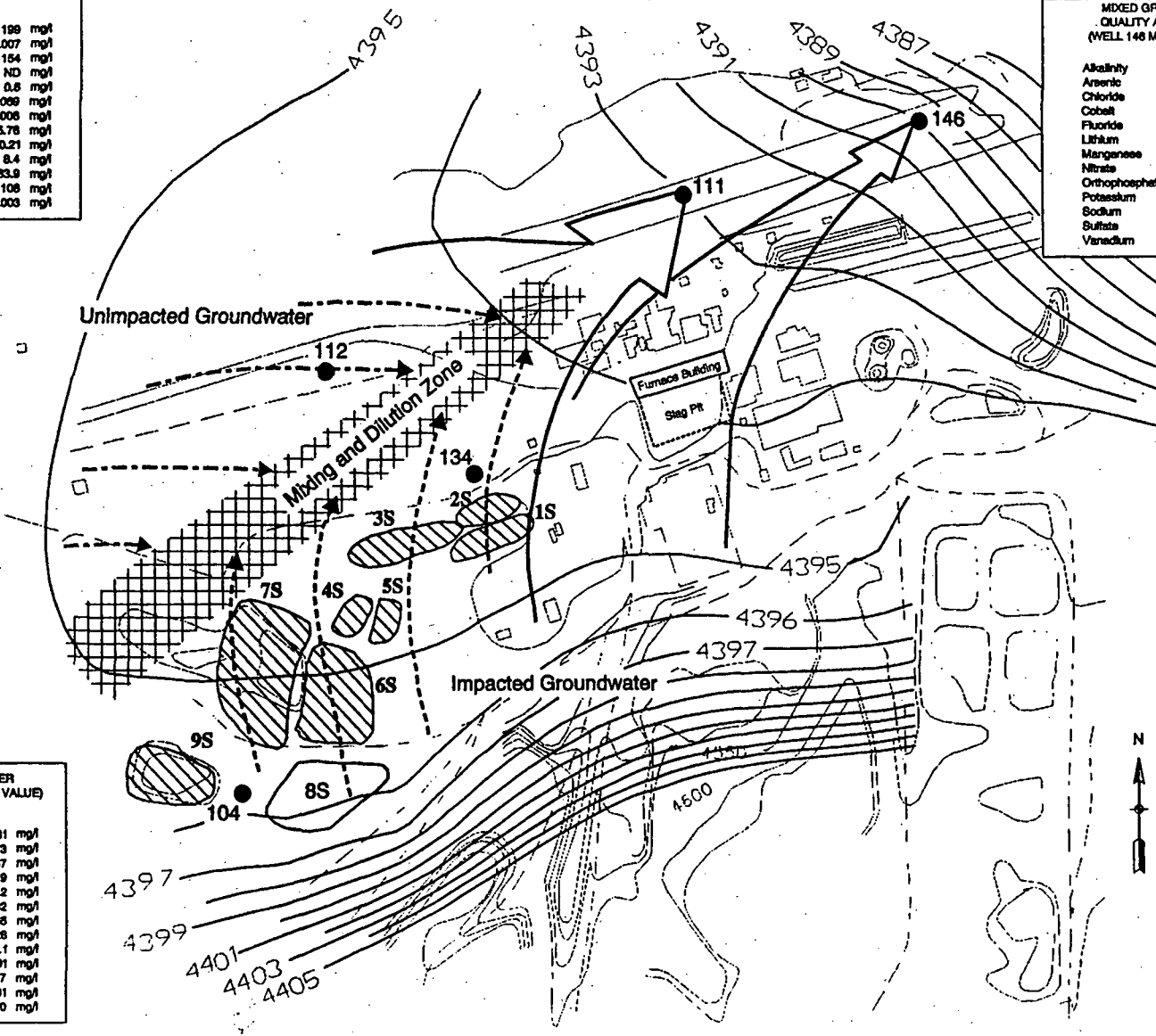
EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Groundwater Flow in the
Central Area of the FMC Facility

| Job Number | Drawing No. | P |
|------------|---------------|---|
| 21372 | FIGURE 4.4-11 | |

IMPACTED GROUNDWATER QUALITY (WELL 134 MAXIMUM VALUE)

| | |
|----------------|------------|
| Alkalinity | 581 mg/l |
| Arsenic | 0.173 mg/l |
| Chloride | 337 mg/l |
| Cobalt | 0.019 mg/l |
| Fluoride | 0.2 mg/l |
| Lithium | 0.132 mg/l |
| Manganese | 3.66 mg/l |
| Nitrate | 2.28 mg/l |
| Orthophosphate | 36.1 mg/l |
| Potassium | 201 mg/l |
| Sodium | 497 mg/l |
| Sulfate | 281 mg/l |
| Vanadium | 0.020 mg/l |



Manganese in Groundwater Wells

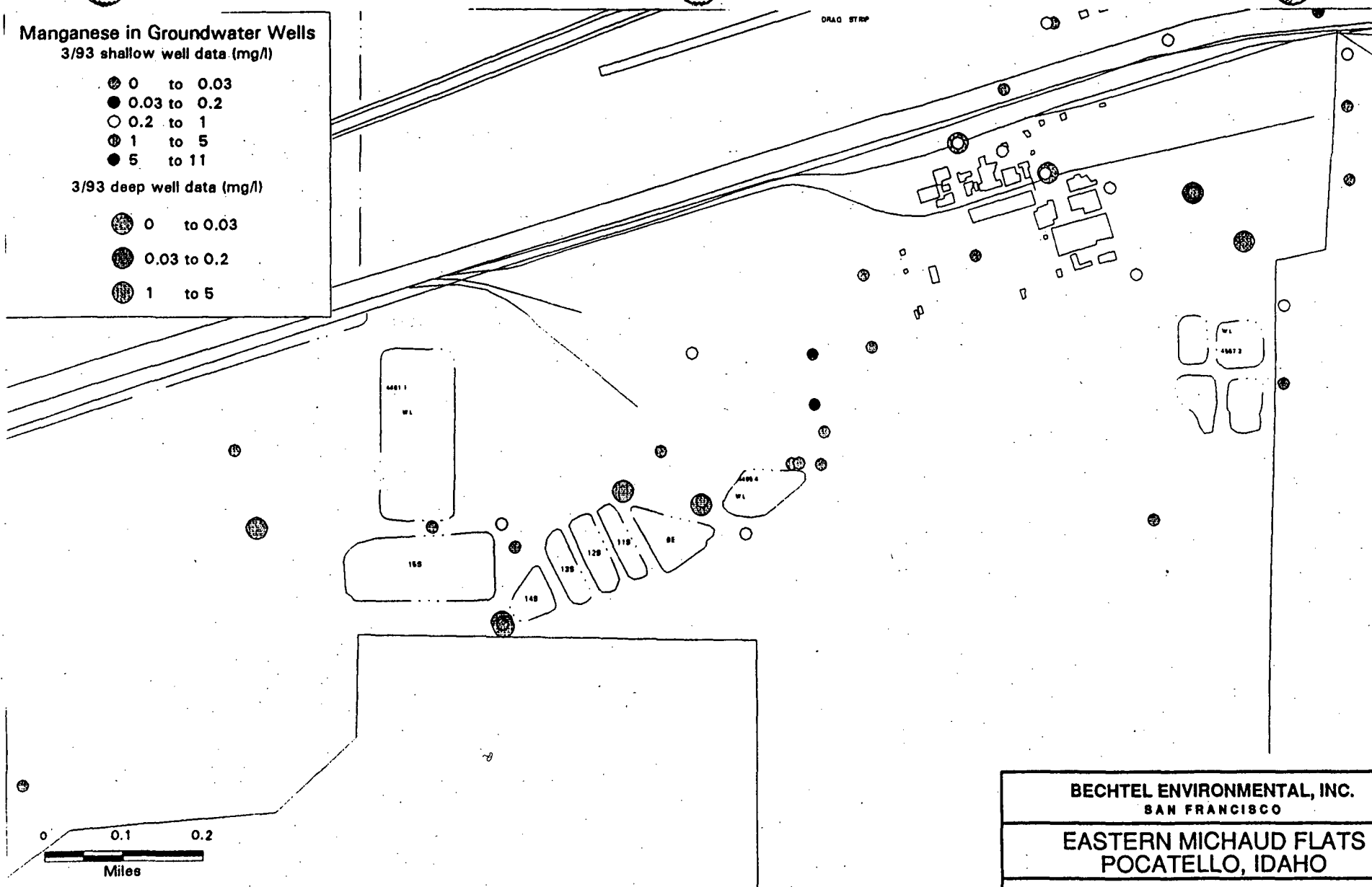
3/93 shallow well data (mg/l)

- 0 to 0.03
- 0.03 to 0.2
- 0.2 to 1
- 1 to 5
- 5 to 11

3/93 deep well data (mg/l)

- 0 to 0.03
- 0.03 to 0.2
- 1 to 5

DRAG STRIP



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Manganese in Groundwater at FMC



JOB No.

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DRAWING NO.

FIGURE 4.4-12

REV.

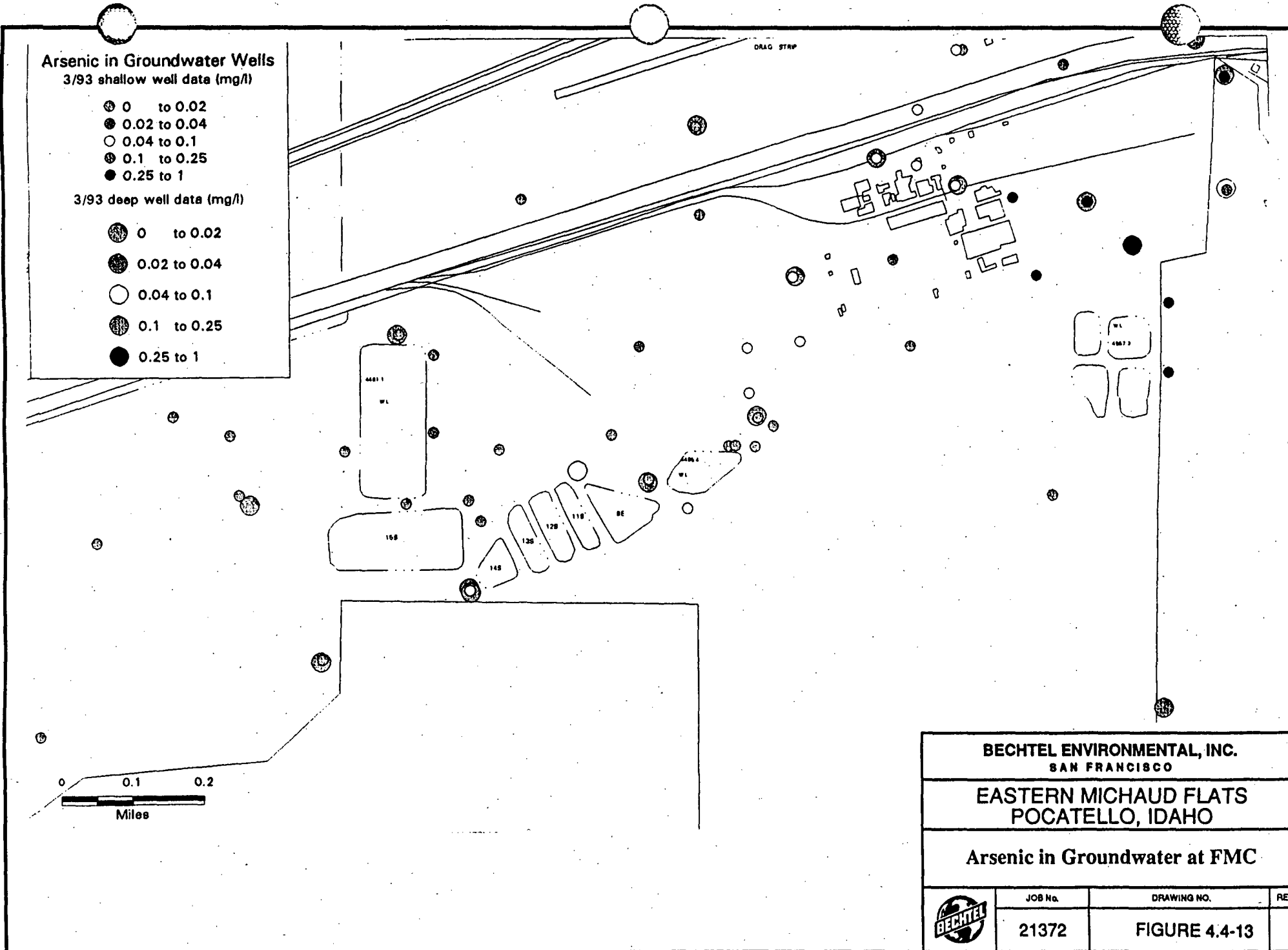
Arsenic in Groundwater Wells

3/93 shallow well data (mg/l)

- 0 to 0.02
- 0.02 to 0.04
- 0.04 to 0.1
- 0.1 to 0.25
- 0.25 to 1

3/93 deep well data (mg/l)

- 0 to 0.02
- 0.02 to 0.04
- 0.04 to 0.1
- 0.1 to 0.25
- 0.25 to 1



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Arsenic in Groundwater at FMC



JOB No.

21372

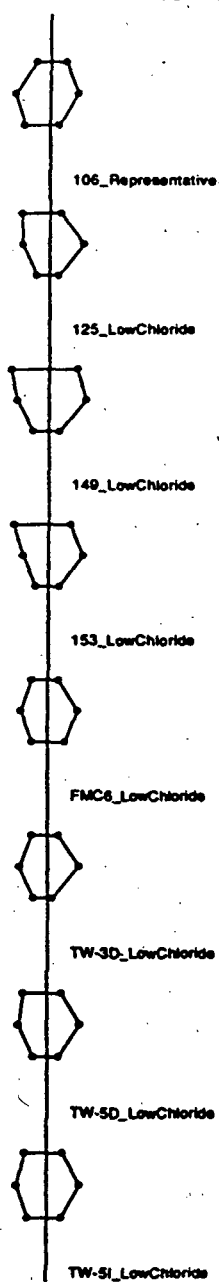
DRAWING NO.

FIGURE 4.4-13

REV.

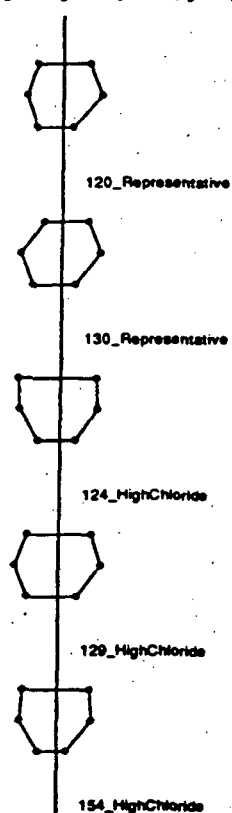
Cations meq/l Anions

25 20 15 10 5 0 5 10 15 20 25



Cations meq/l Anions

25 20 15 10 5 0 5 10 15 20 25



Legend

| Cations | Anions |
|---------|------------------------------------|
| Na + K | Cl |
| Ca | HCO ₃ + CO ₃ |
| Mg | SO ₄ |

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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Stiff Diagrams for Wells with Unimpacted
Michaud Flats Regime Water Chemistry



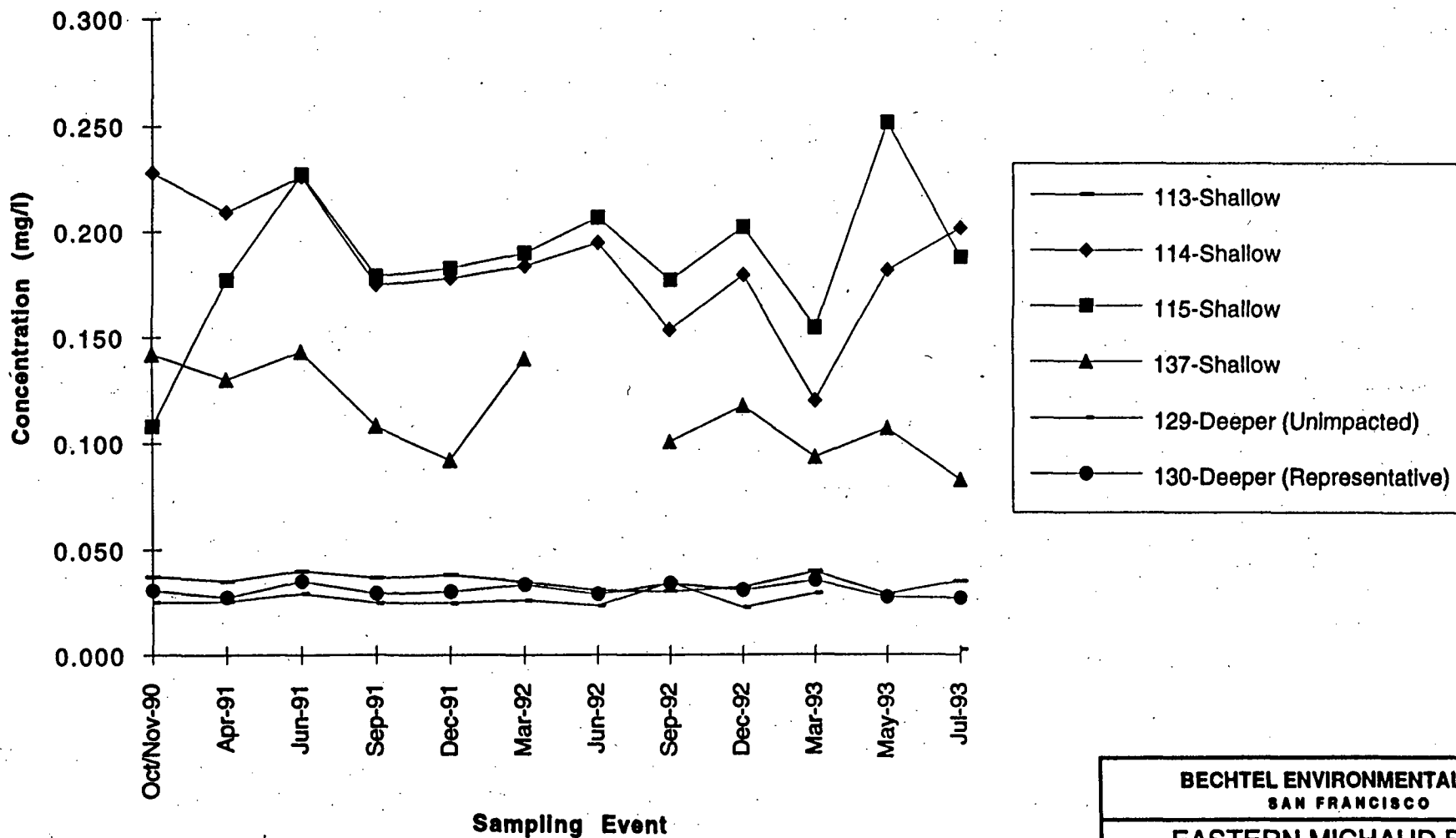
JOB No.

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FIGURE 4.4-14



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Arsenic Trends in Groundwater in
Southwestern Area of FMC Facility:
Wells 113, 114, 115, 137, 129, 130



JOB No.

21372

DRAWING NO.

FIGURE 4.4-15

REV.

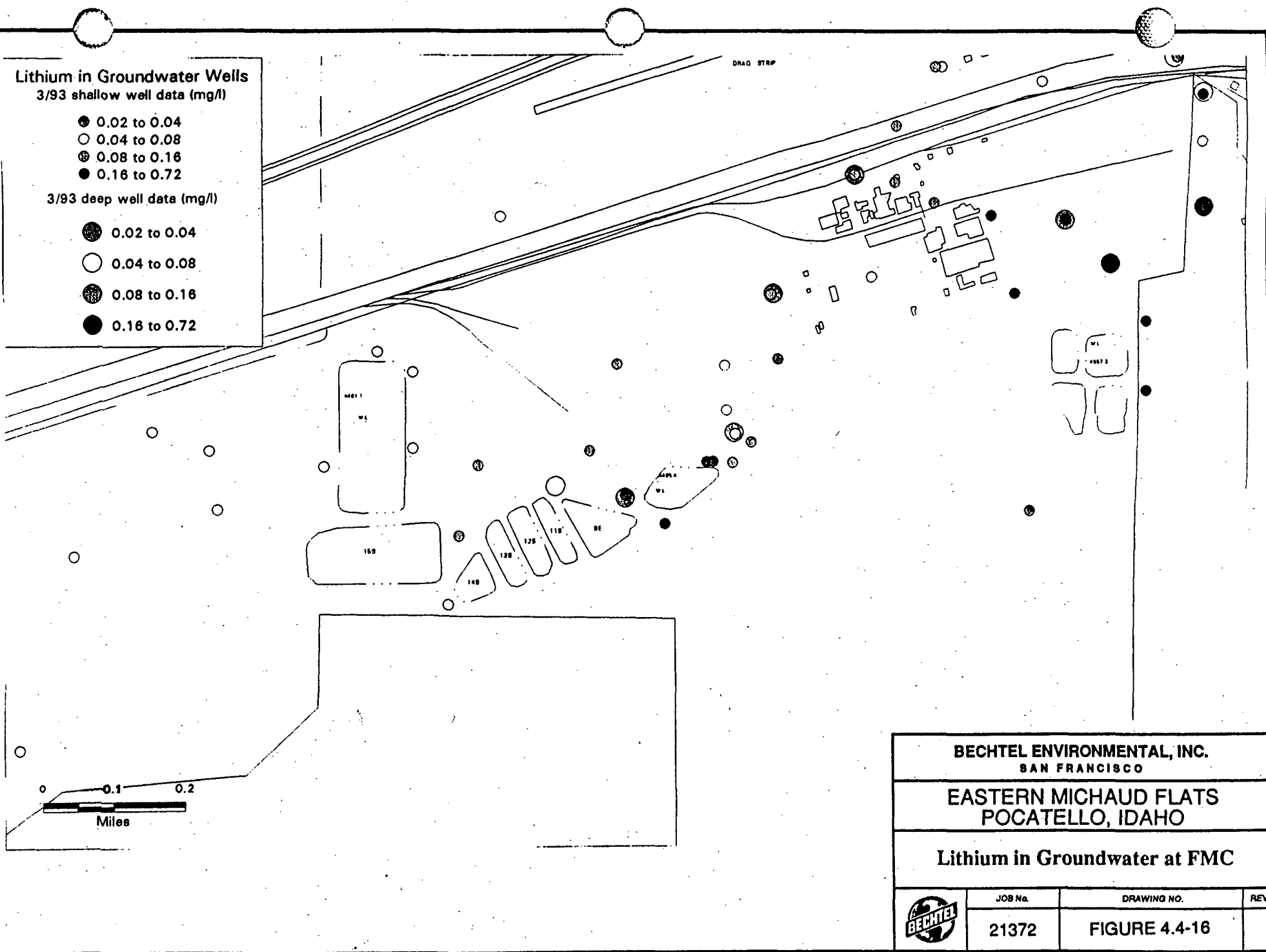
Lithium in Groundwater Wells

3/93 shallow well data (mg/l)

- 0.02 to 0.04
- 0.04 to 0.08
- ◐ 0.08 to 0.16
- 0.16 to 0.72

3/93 deep well data (mg/l)

- 0.02 to 0.04
- 0.04 to 0.08
- ◐ 0.08 to 0.16
- 0.16 to 0.72



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Lithium in Groundwater at FMC



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DRAWING NO.

FIGURE 4.4-16

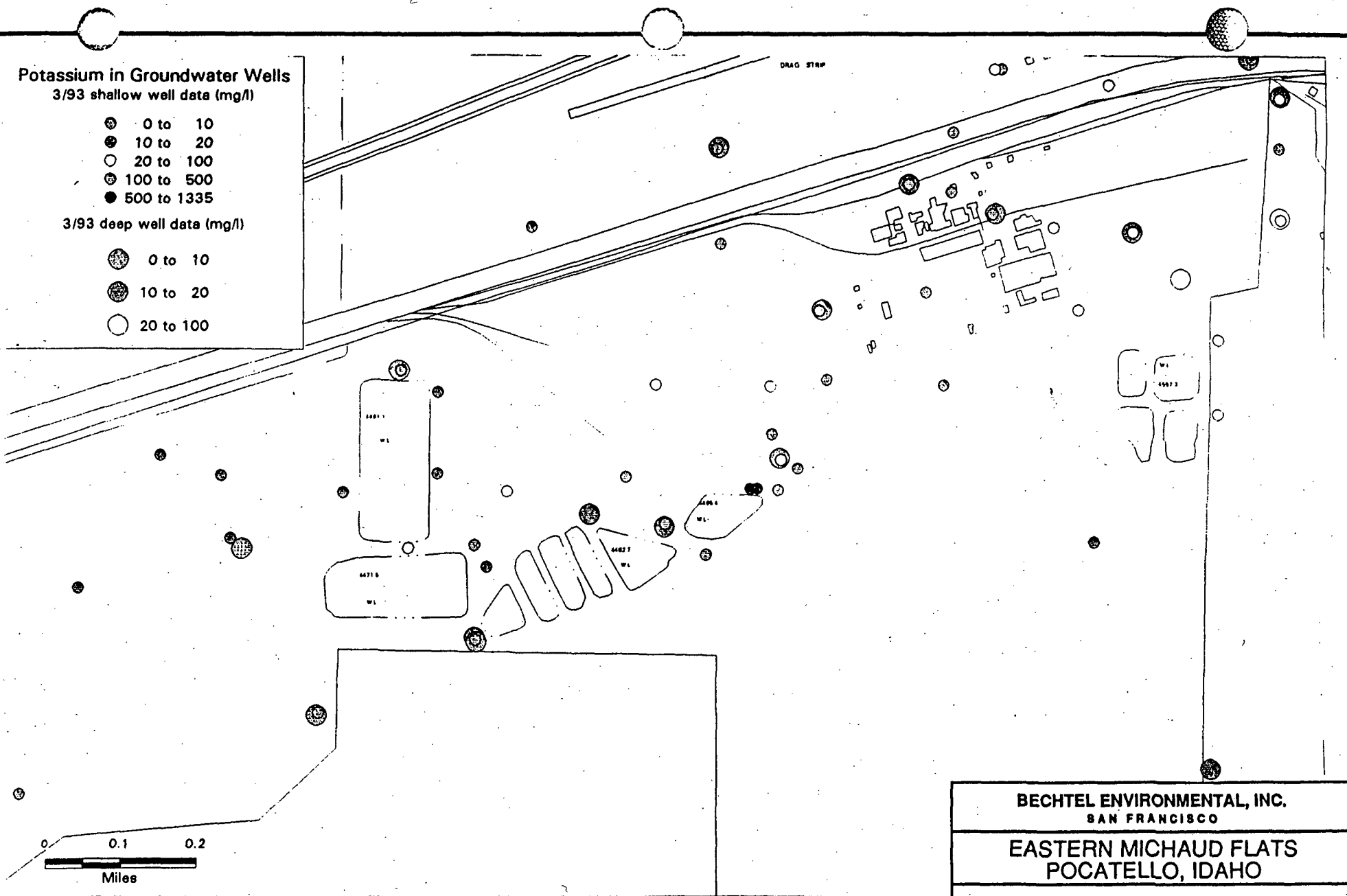
REV.

Potassium in Groundwater Wells
3/93 shallow well data (mg/l)

- 0 to 10
- 10 to 20
- 20 to 100
- 100 to 500
- 500 to 1335

3/93 deep well data (mg/l)

- 0 to 10
- 10 to 20
- 20 to 100



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Potassium in Groundwater at FMC



JOB No.

21372

DRAWING NO.

FIGURE 4.4-17

REV.

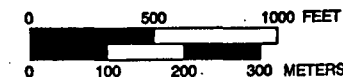
[illegible]

122 Well Designation


- Well Location




21.1 Temperature (degrees C)
(August 1993)

- * Deeper Well



Temperature Pattern in Groundwater at FMC

| | | |
|---|------------|---------------|
|  | Job Number | Drawing No. |
| | 21372 | FIGURE 4.4-18 |

 Flowpaths within Simplot
 Production Well Capture Zone
 Groundwater Flowpaths
 Facility Boundaries


- Shallow Monitoring Well
- ◎ Deep Monitoring Well
- Production Well



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**EASTERN MICHAUD FLATS
POCATELLO, IDAHO**

Conceptualized Groundwater Flow in the Vicinity of Simplot Production Wells

| | | |
|---|------------|---------------|
|  | Job Number | Drawing No. |
| | 21372 | FIGURE 4.4-19 |

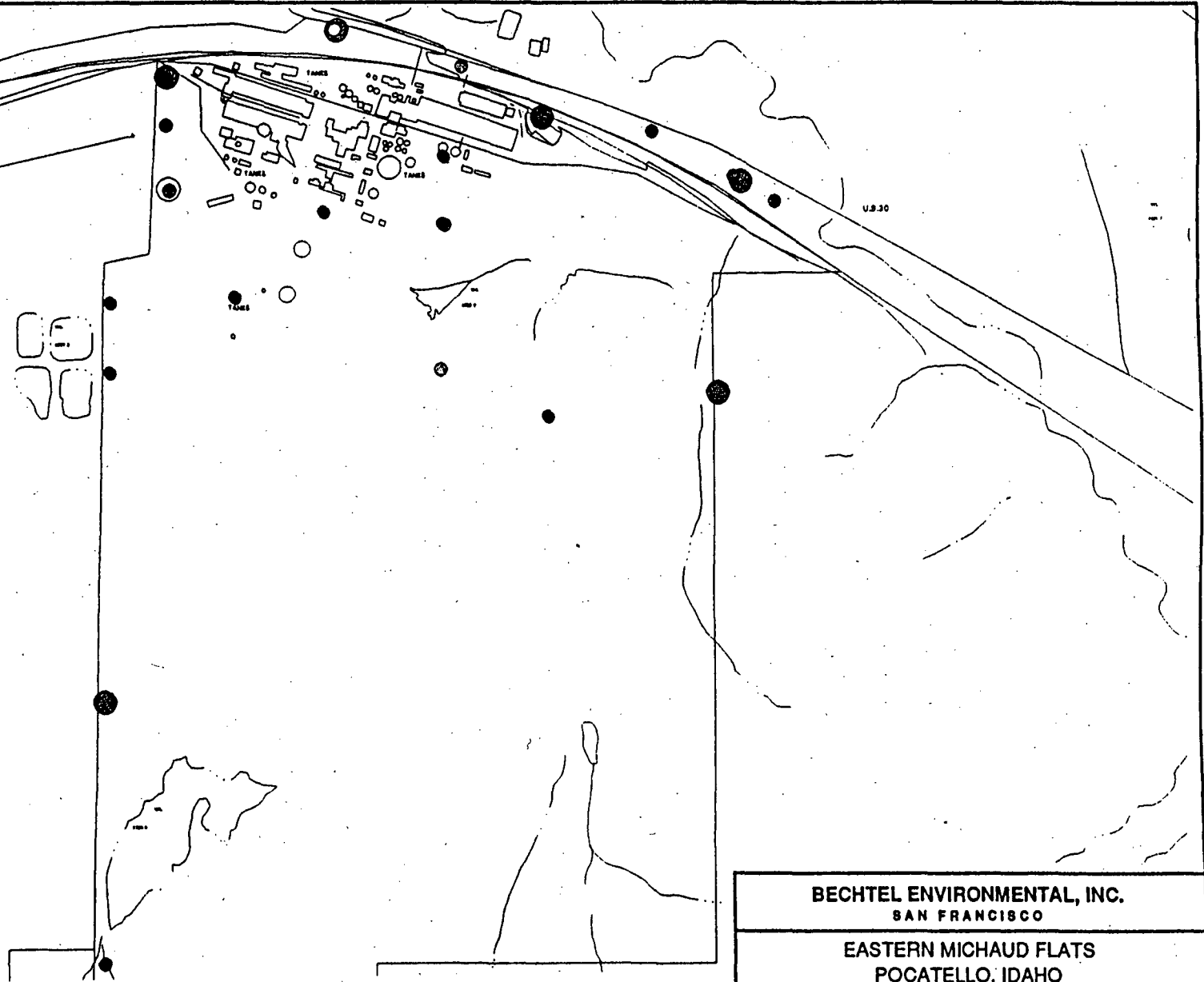
Arsenic in Groundwater
3/93 shallow well data (mg/l)

- 0 to 0.02
- ⊗ 0.02 to 0.04
- 0.04 to 0.1
- 0.1 to 0.25
- 0.25 to 1

3/93 deep well data (mg/l)

- 0 to 0.02
- ⊗ 0.02 to 0.04
- 0.04 to 0.1
- 0.25 to 1

0 0.1 0.2
Miles



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Arsenic in Groundwater at Simplot



JOB No.

21372

DRAWING NO.

FIGURE 4.4-20

REV.

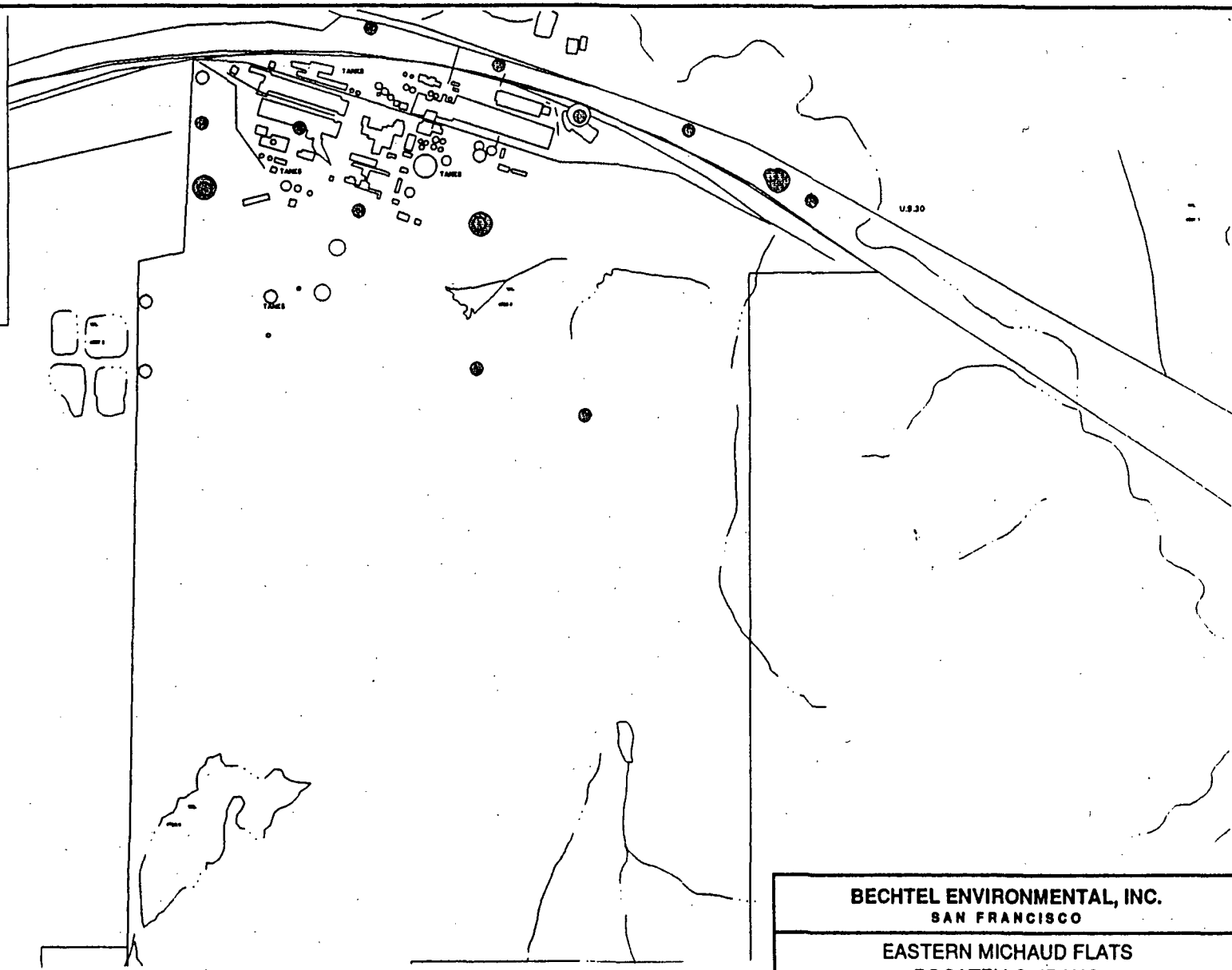
Boron in Groundwater Wells

3/93 shallow well data (mg/l)

- 0 to 0.2
- 0.2 to 0.6
- 0.6 to 1
- 1 to 7

3/93 deep well data (mg/l)

- 0 to 0.2
- 0.2 to 0.6
- 0.6 to 1



0 0.15 0.3
Miles

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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Boron in Groundwater at Simplot



JOB No.

DRAWING NO.

REV.

21372

FIGURE 4.4-21

Lithium in Groundwater Wells

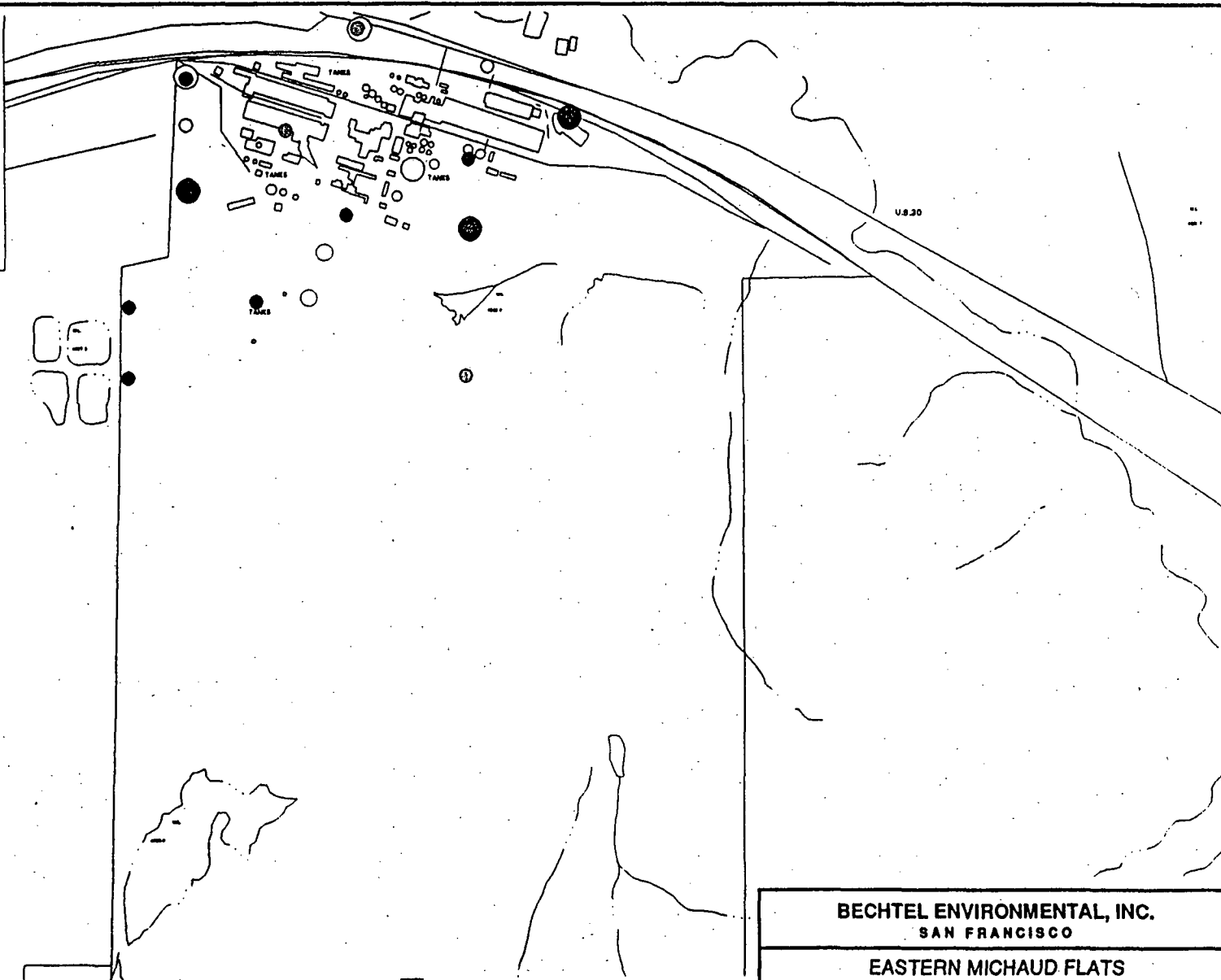
3/93 shallow well data (mg/l)

- 0.04 to 0.08
- 0.08 to 0.16
- 0.16 to 0.72

3/93 deep well data (mg/l)

- 0.04 to 0.08
- 0.16 to 0.3

0 0.15 0.3
Miles



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Lithium in Groundwater at Simplot



JOB No.

DRAWING NO.

REV.

21372

FIGURE 4.4-22

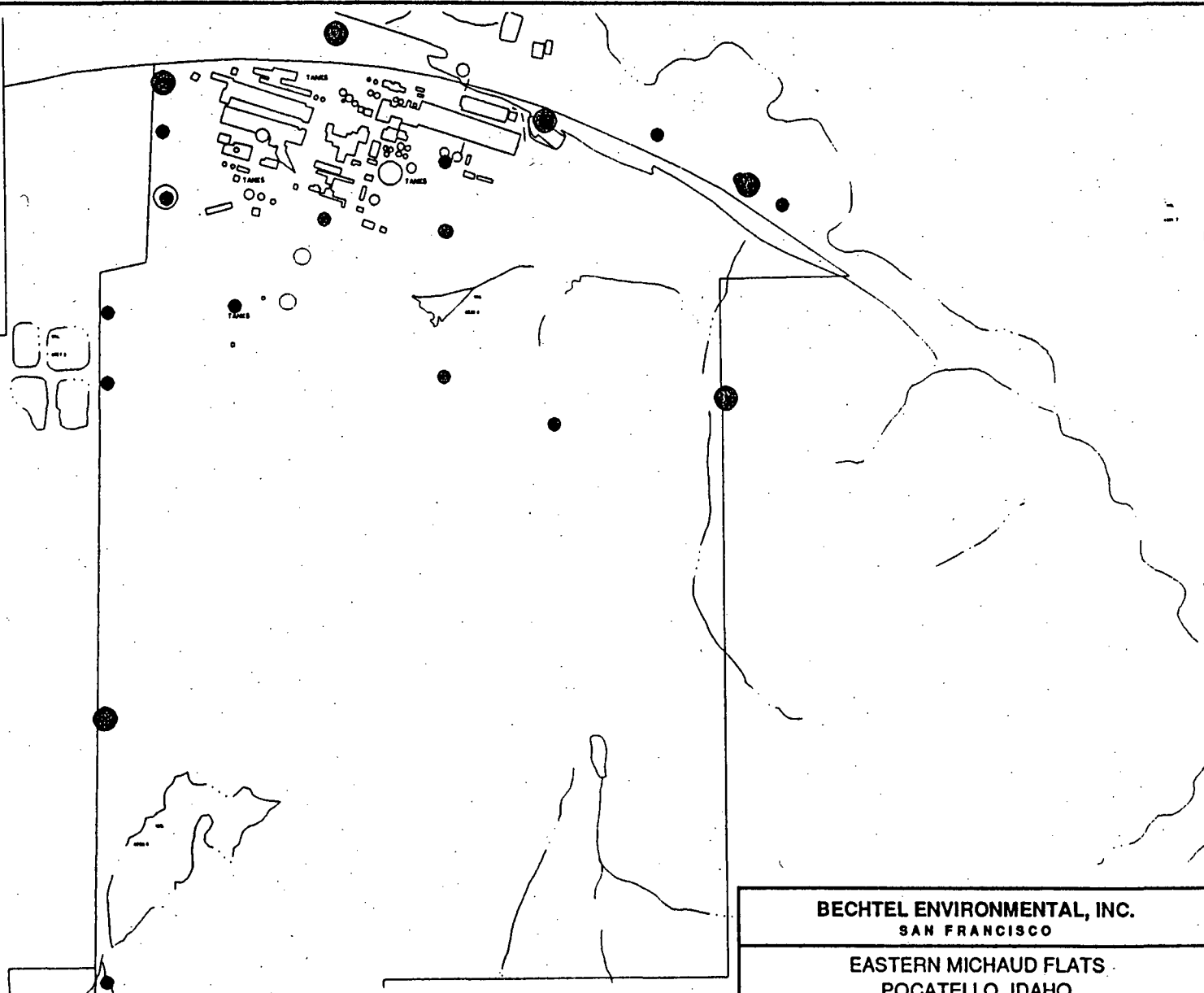
Orthophosphate in Groundwater

3/93 shallow well data (mg/l)

- 0 to 0.4
- 2 to 10
- 10 to 100
- 100 to 2600

3/93 deep well data (mg/l)

- 0 to 0.4
- 2 to 10
- 10 to 100



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Orthophosphate in Groundwater at Simplot



JOB No.

DRAWING NO.

REV.

21372

FIGURE 4.4-23

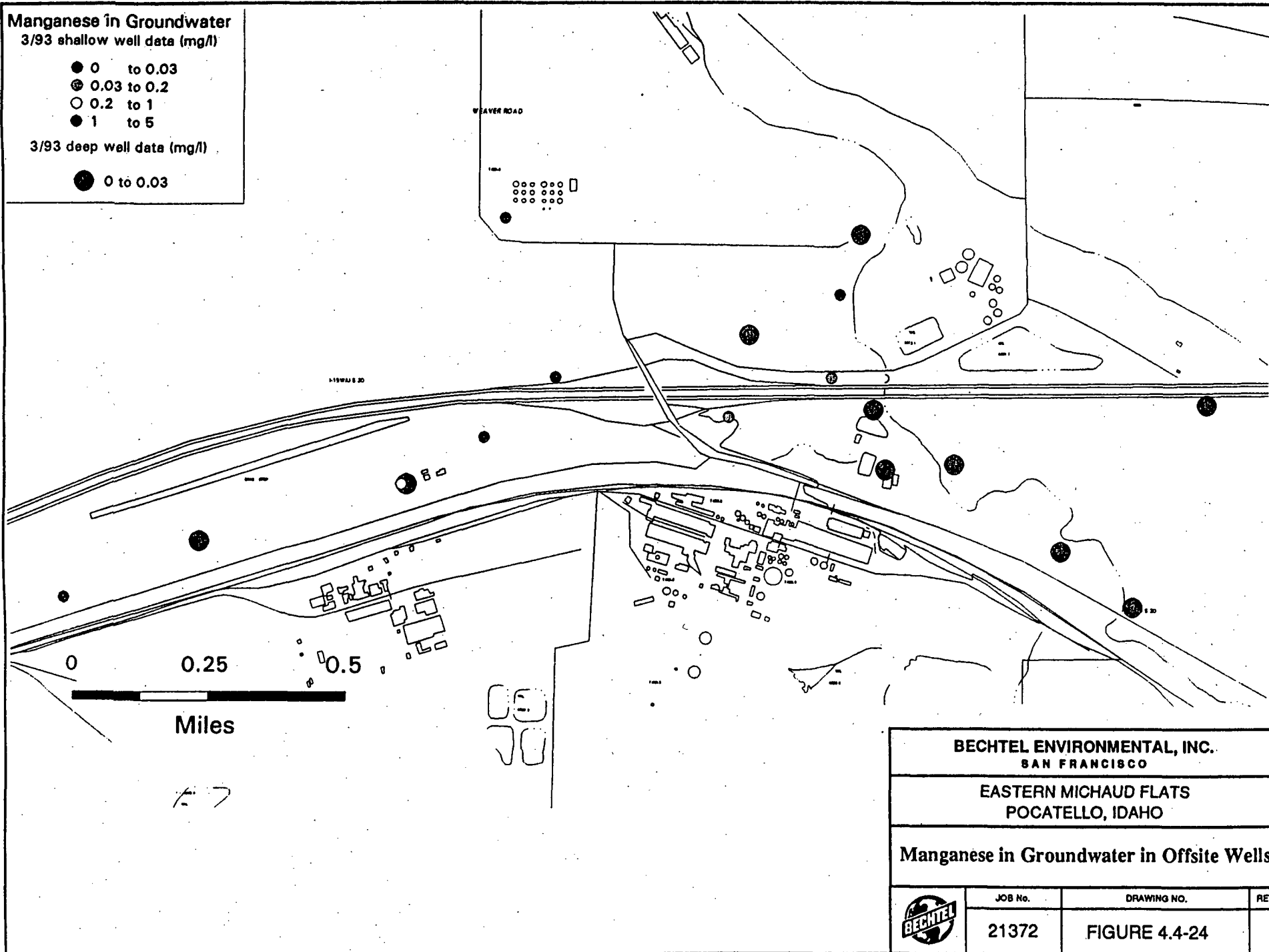
Manganese in Groundwater

3/93 shallow well data (mg/l)

- 0 to 0.03
- ⊙ 0.03 to 0.2
- 0.2 to 1
- 1 to 5

3/93 deep well data (mg/l)

- 0 to 0.03

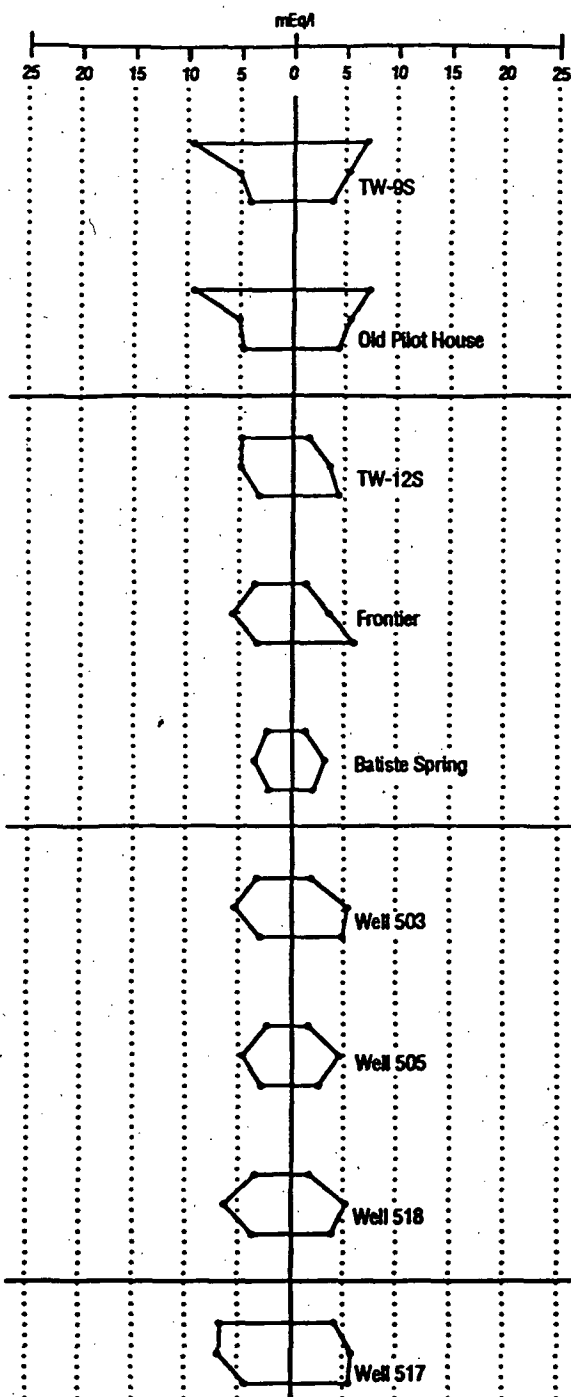


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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Manganese in Groundwater in Offsite Wells

| BECHTEL | JOB No. | DRAWING NO. | REV. |
|---------|---------|---------------|------|
| | 21372 | FIGURE 4.4-24 | |



a) Michaud Flats

b) Bannock Range

c) Portneuf River

d) Undetermined Regime

Note:
Milliequivalent concentrations calculated from mean low concentrations
for data collected between September 1992 and August 1993

Legend

| Cations | Anions |
|---------|------------------------------------|
| Na + K | Cl |
| Ca | HCO ₃ + CO ₃ |
| Mg | SO ₄ |

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BECHTEL ENVIRONMENTAL, INC.
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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Stiff Diagrams for Offsite Water with
Elevated Common Ion Concentrations



JOB No.

21372

DRAWING NO.

FIGURE 4.4-25

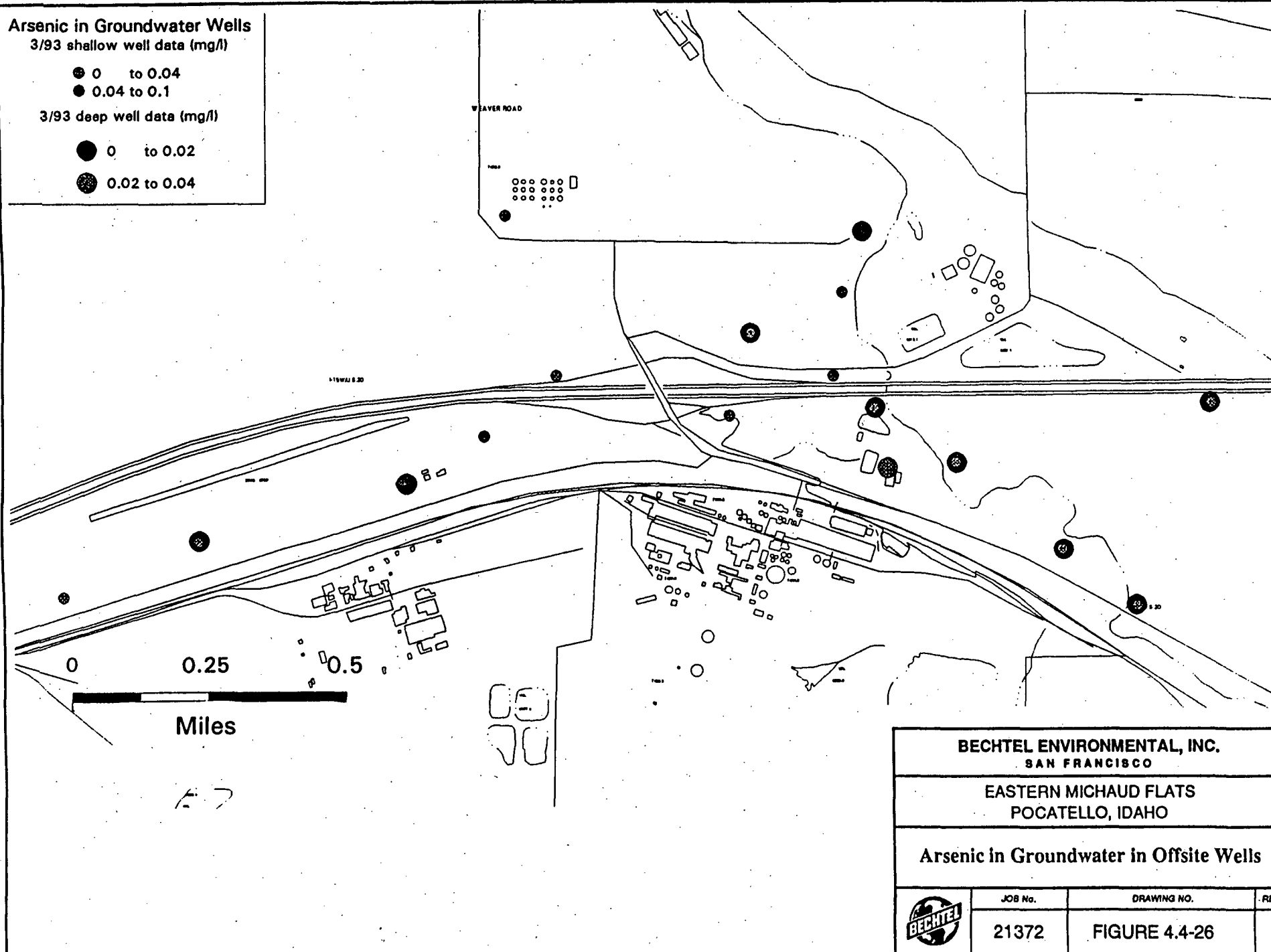
REV.

Arsenic in Groundwater Wells
3/93 shallow well data (mg/l)

- 0 to 0.04
- 0.04 to 0.1

3/93 deep well data (mg/l)

- 0 to 0.02
- 0.02 to 0.04



BECHTEL ENVIRONMENTAL, INC.
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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Arsenic in Groundwater in Offsite Wells



JOB No.

21372

DRAWING NO.

FIGURE 4.4-26

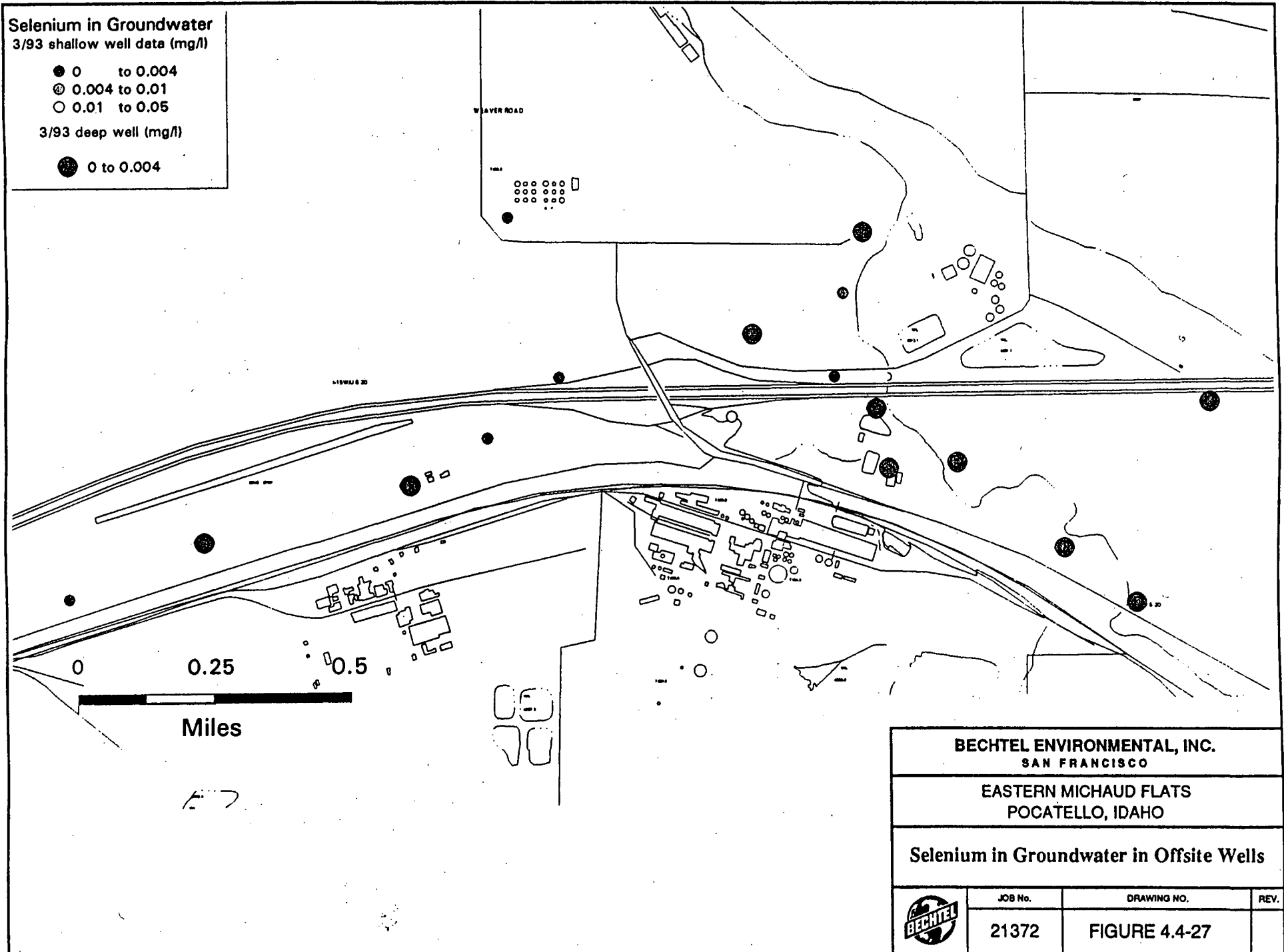
REV.

Selenium in Groundwater
3/93 shallow well data (mg/l)

- 0 to 0.004
- ⊗ 0.004 to 0.01
- 0.01 to 0.05

3/93 deep well (mg/l)

- 0 to 0.004



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Selenium in Groundwater in Offsite Wells



JOB No.

21372

DRAWING NO.

FIGURE 4.4-27

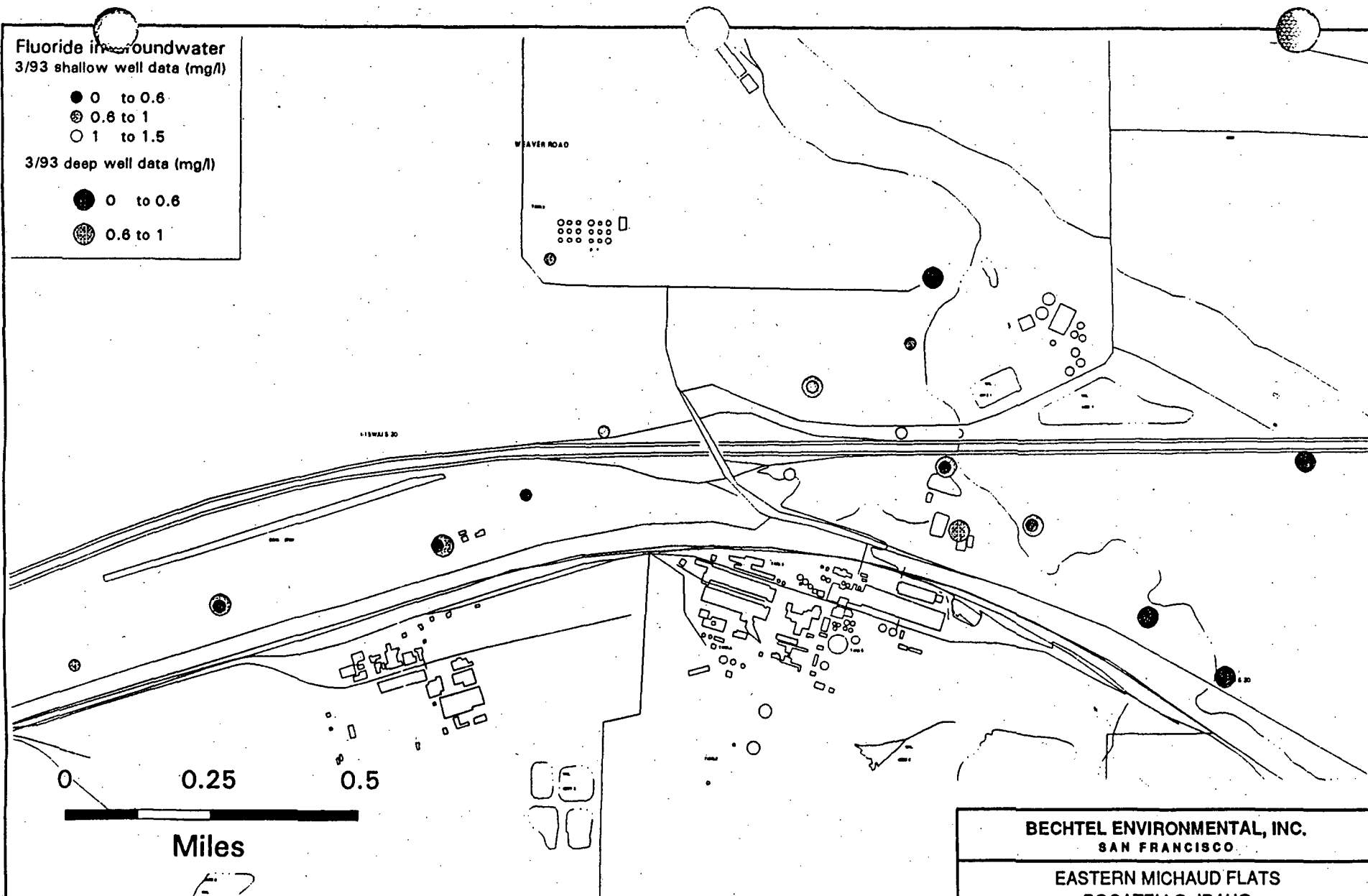
REV.

Fluoride in Groundwater
3/93 shallow well data (mg/l)

- 0 to 0.6
- ⊗ 0.6 to 1
- 1 to 1.5

3/93 deep well data (mg/l)

- 0 to 0.6
- ⊗ 0.6 to 1



BECHTEL ENVIRONMENTAL, INC.
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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Fluoride in Groundwater in Offsite Wells



JOB No.

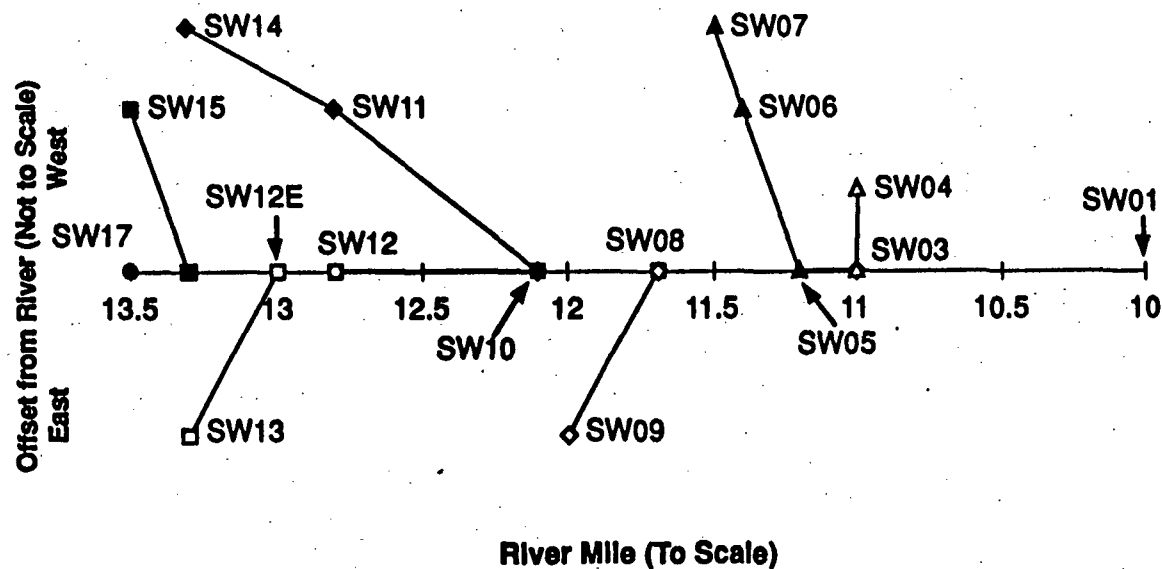
DRAWING NO.

REV.

21372

FIGURE 4.4-28

Figures for Section 4.5



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Relationship of Surface Water
Sampling Locations to Portneuf River



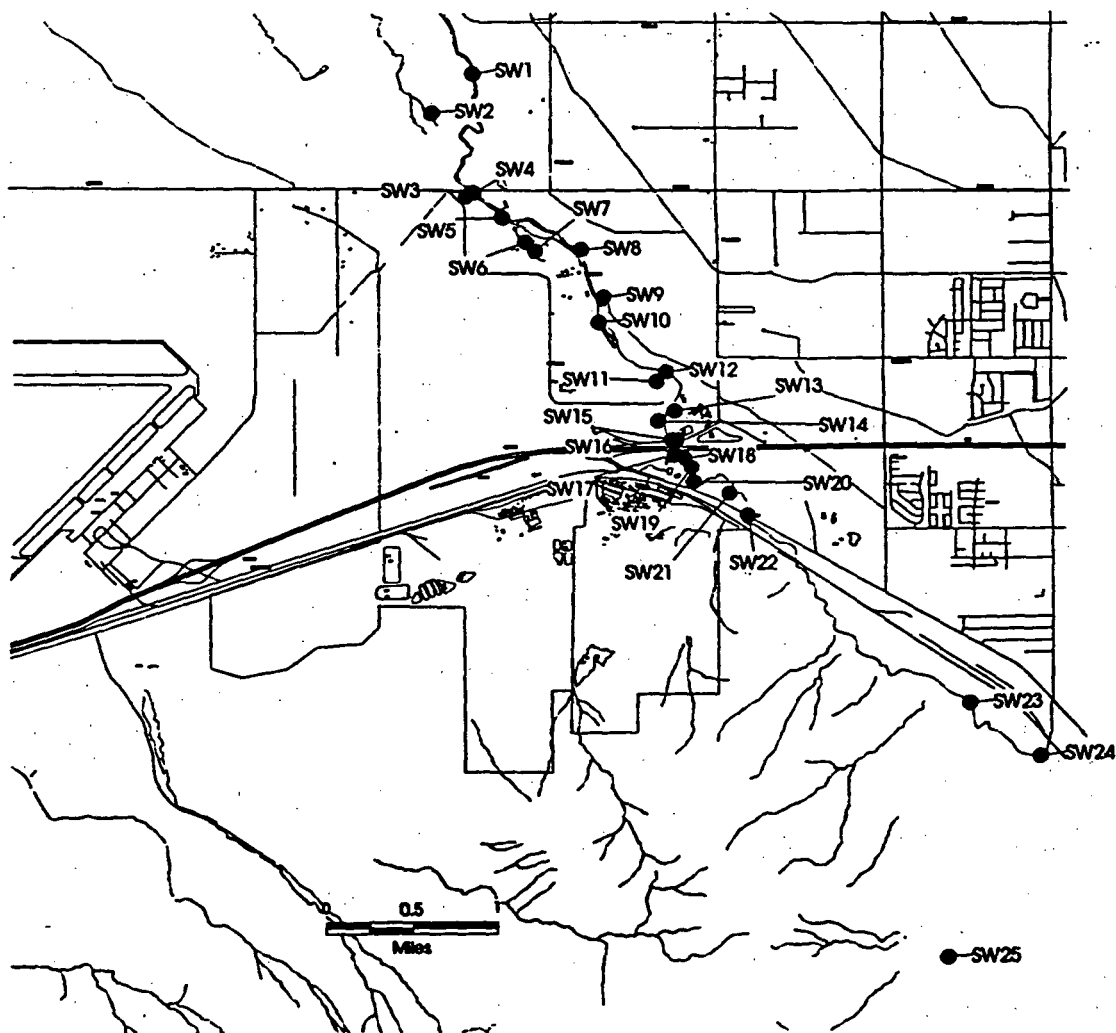
JOB No.

21372

DRAWING NO.

FIGURE 4.5-1

REV.



BECHTEL ENVIRONMENTAL, INC.
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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Surface Water
Sampling Locations



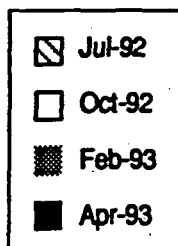
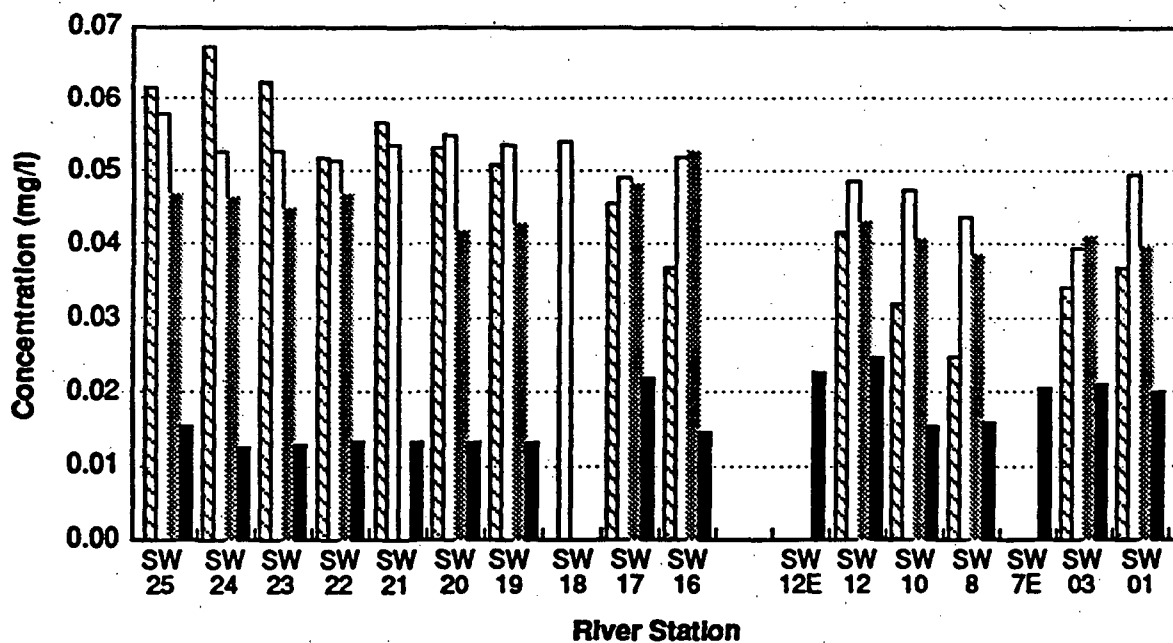
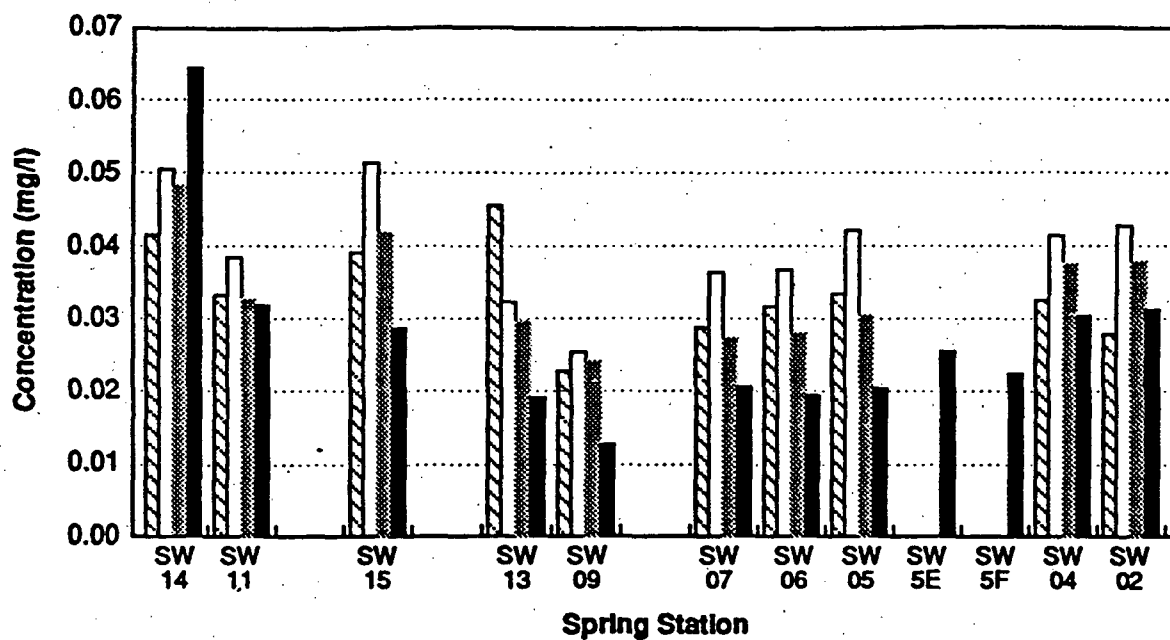
JOB No.

21372

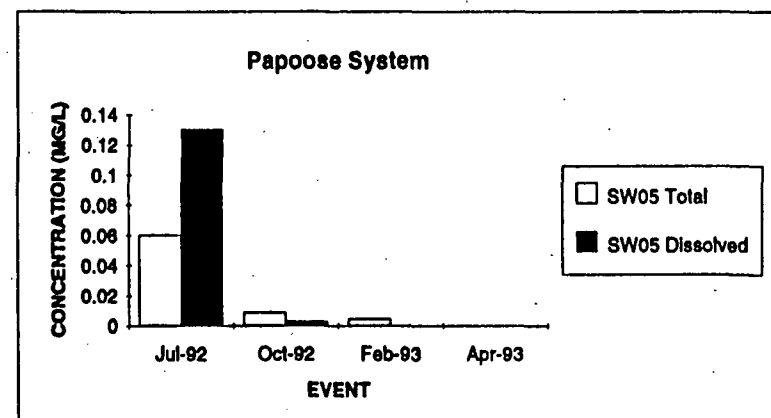
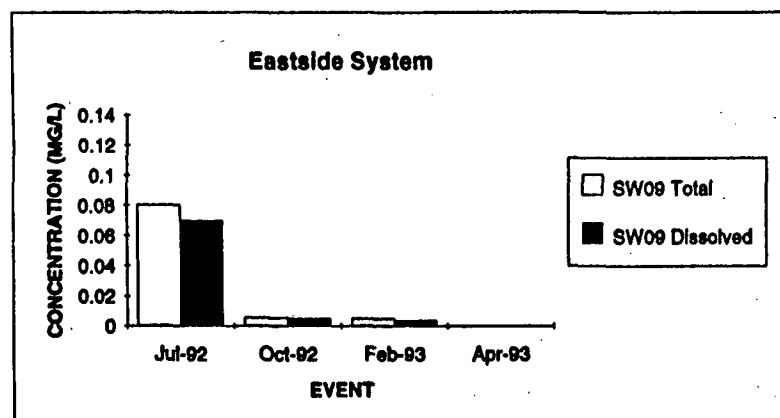
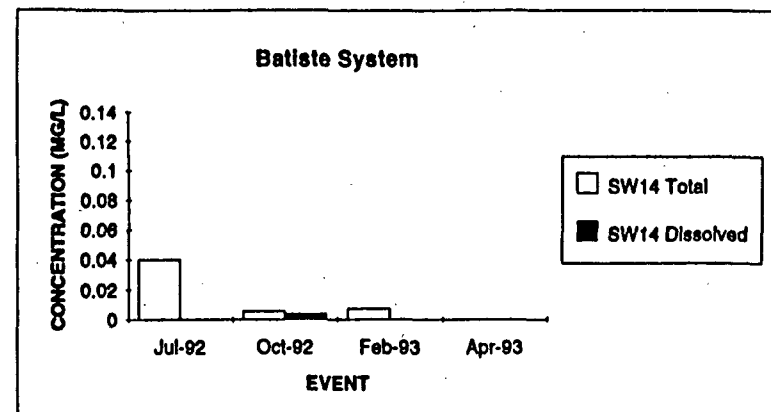
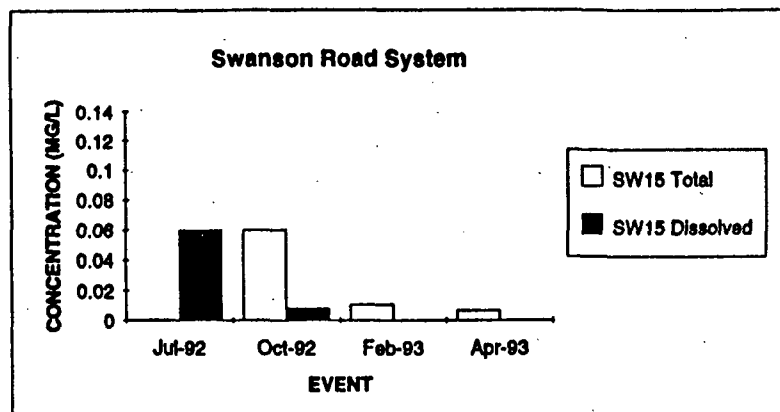
DRAWING NO.

FIGURE 4.5-2


REV.

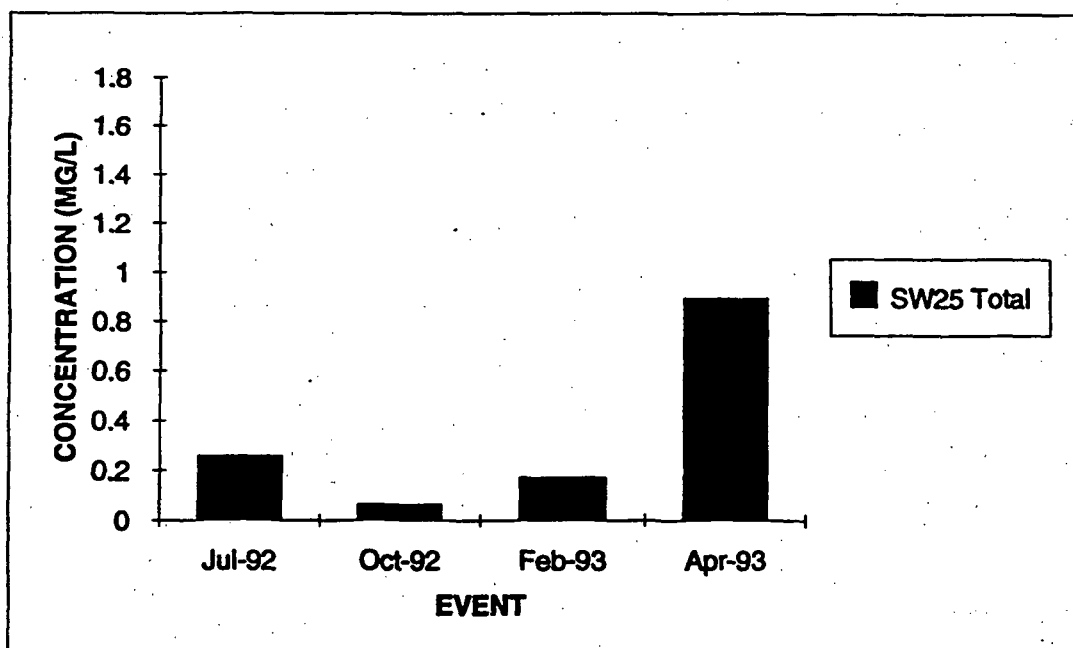
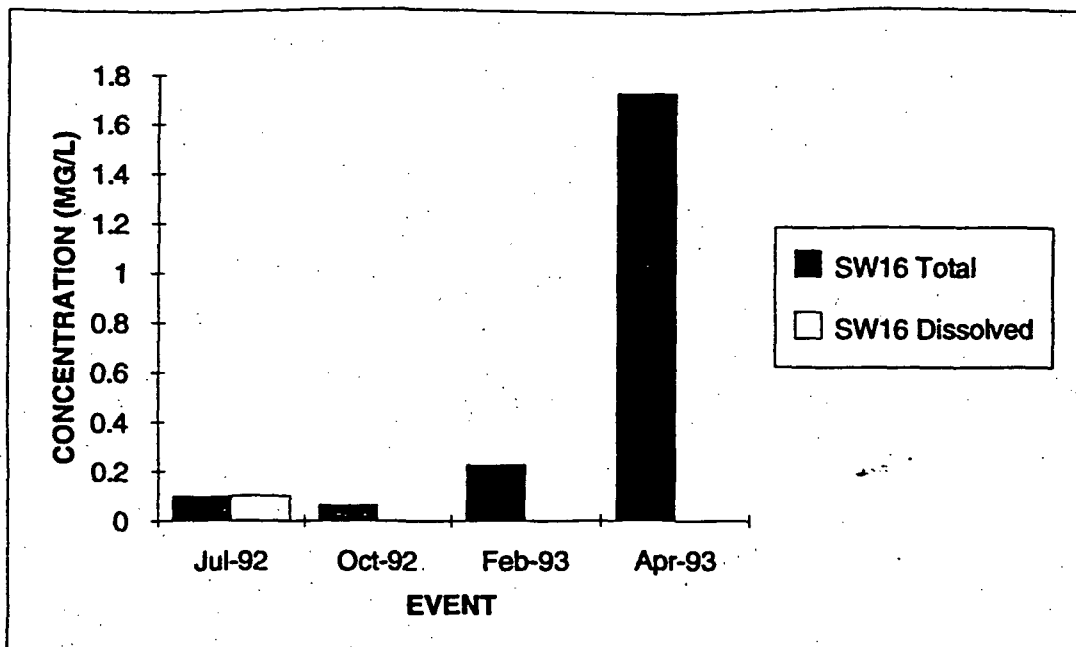


| | | |
|--|---------|--------------|
| BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO | | |
| EASTERN MICHAUD FLATS POCATELLO, IDAHO | | |
| Lithium Concentrations in Surface Water at Springs and River Stations | | |
| | JOB No. | DRAWING NO. |
| | 21372 | FIGURE 4.5-3 |
| | | REV. |



Note: Concentrations are not denoted in this figure for samples in which results were reported as not detected.

| | | | |
|---|---------|--------------|------|
| BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO | | | |
| EASTERN MICHAUD FLATS POCATELLO, IDAHO | | | |
| Vanadium Concentrations for Each Spring System | | | |
|  | JOB No. | DRAWING NO. | REV. |
| | 21372 | FIGURE 4.5-4 | 0 |



Note:
Concentrations are not denoted in this figure
for samples in which results were reported
as not detected.

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Aluminum Concentrations for
River Stations SW25 and SW16



JOB NO.

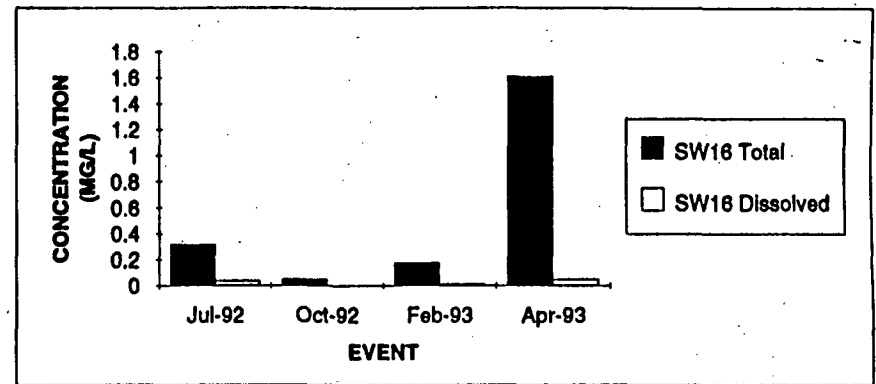
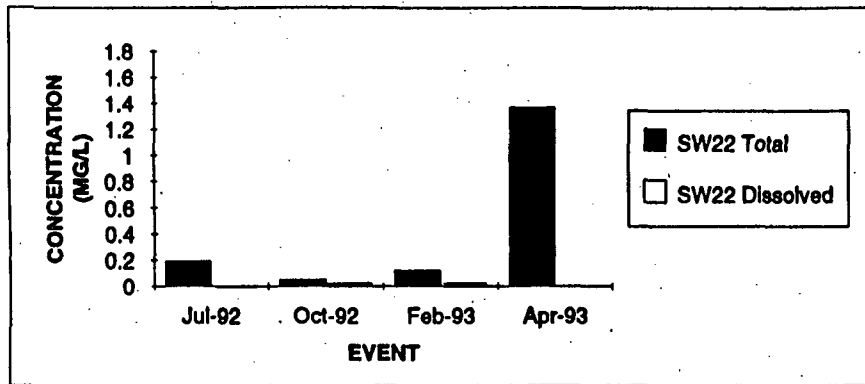
DRAWING NO.

REV.

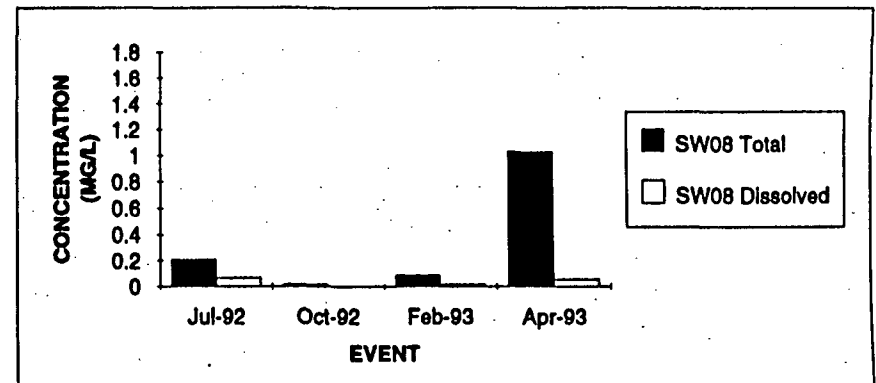
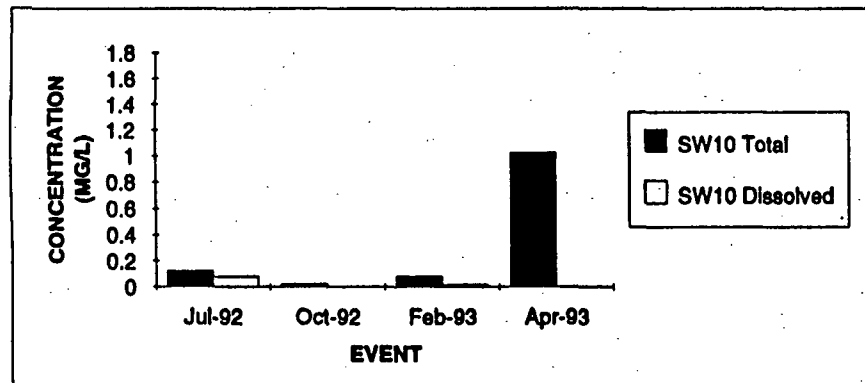
21372

FIGURE 4.5-5

Loosing Reach



Gaining Reach



Note: Concentrations are not denoted in this figure for samples in which results were reported as not detected.

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Iron Concentrations in River Samples



JOB No.

21372

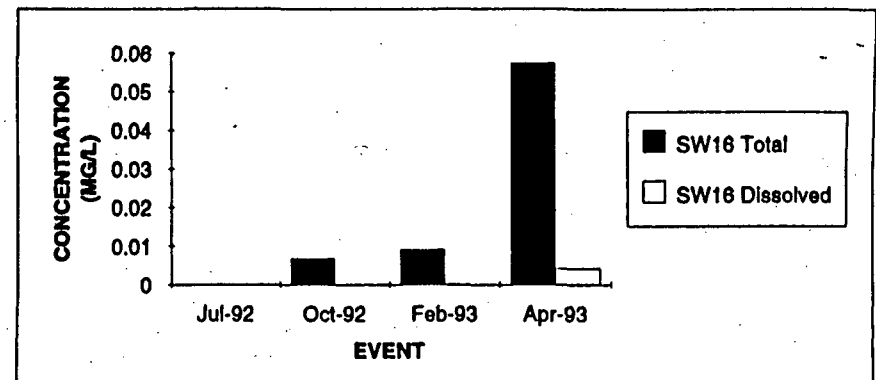
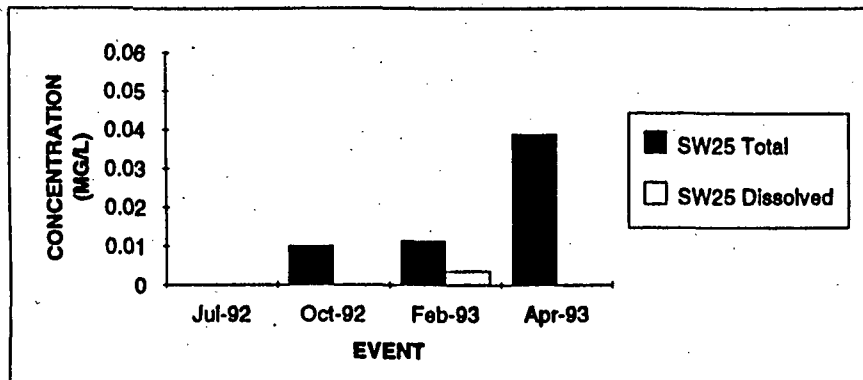
DRAWING NO.

FIGURE 4.5-6

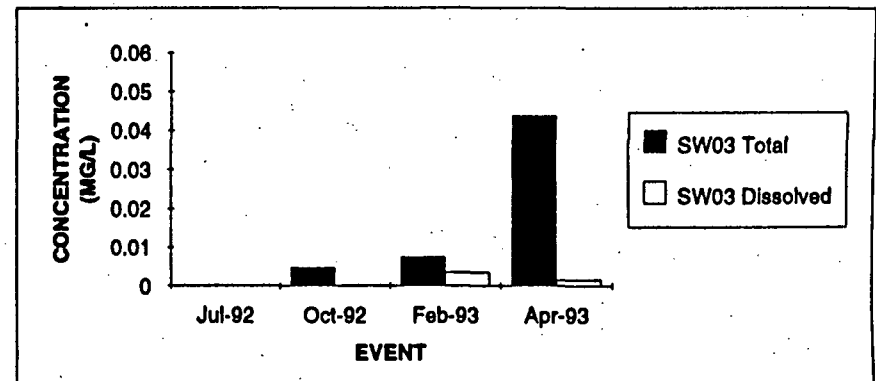
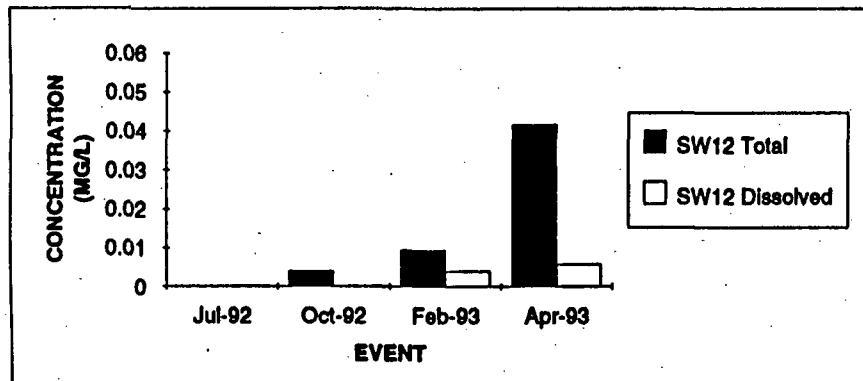
REV.

0

Losing Reach



Gaining Reach



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Manganese Concentrations in
River Samples



JOB No.

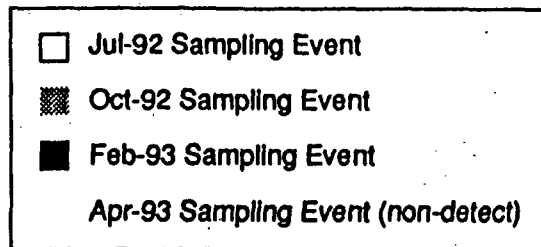
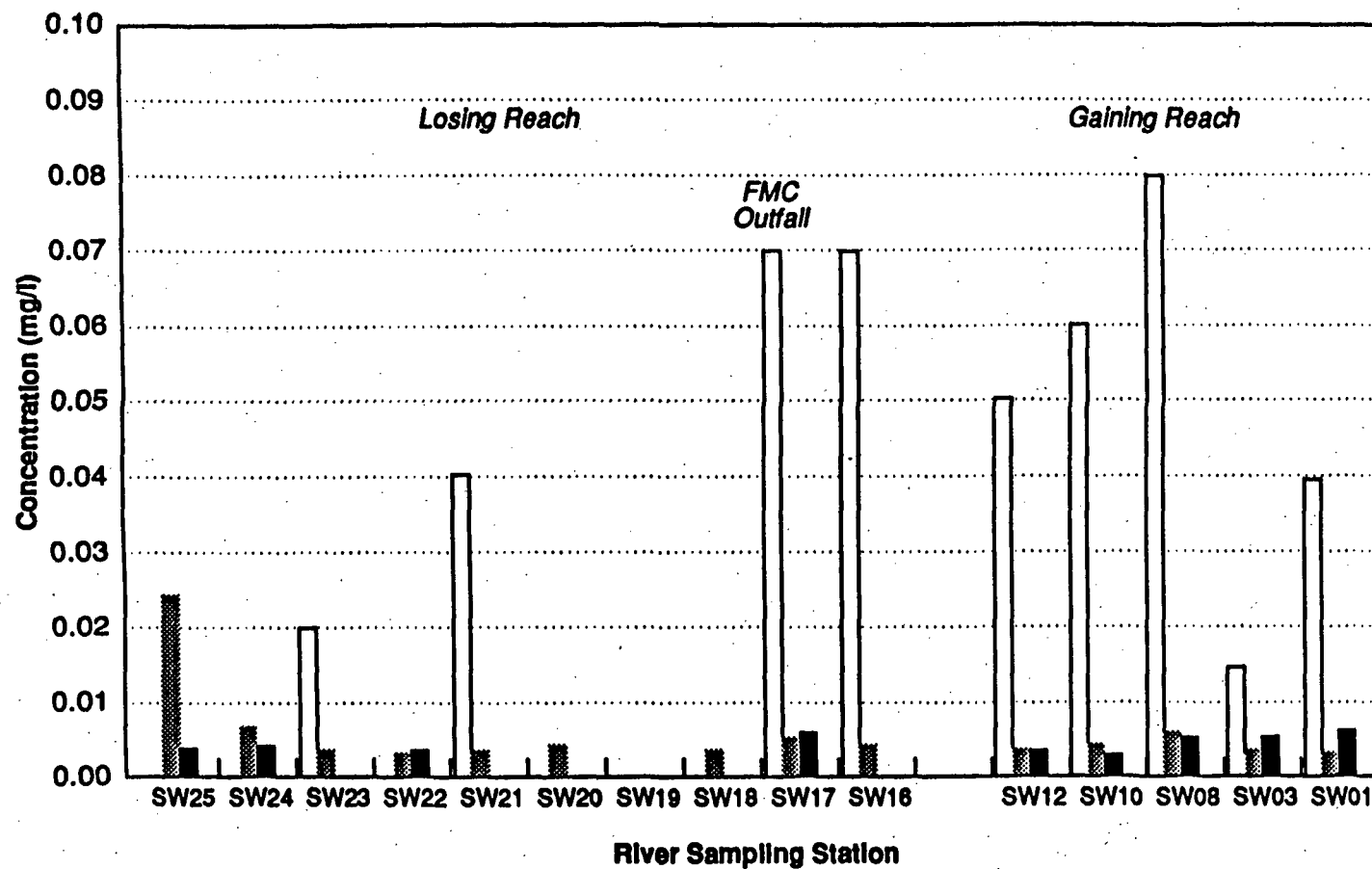
21372

DRAWING NO.

FIGURE 4.5-7

REV.

0



Direction of Stream Flow →

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Vanadium Concentrations in Surface Water
Samples from River Sampling Stations



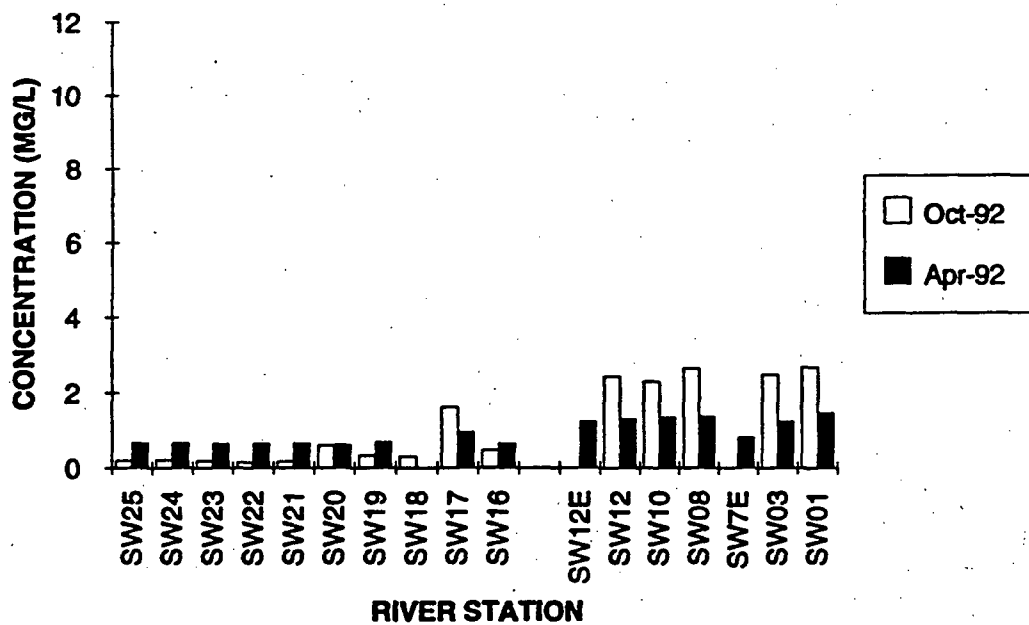
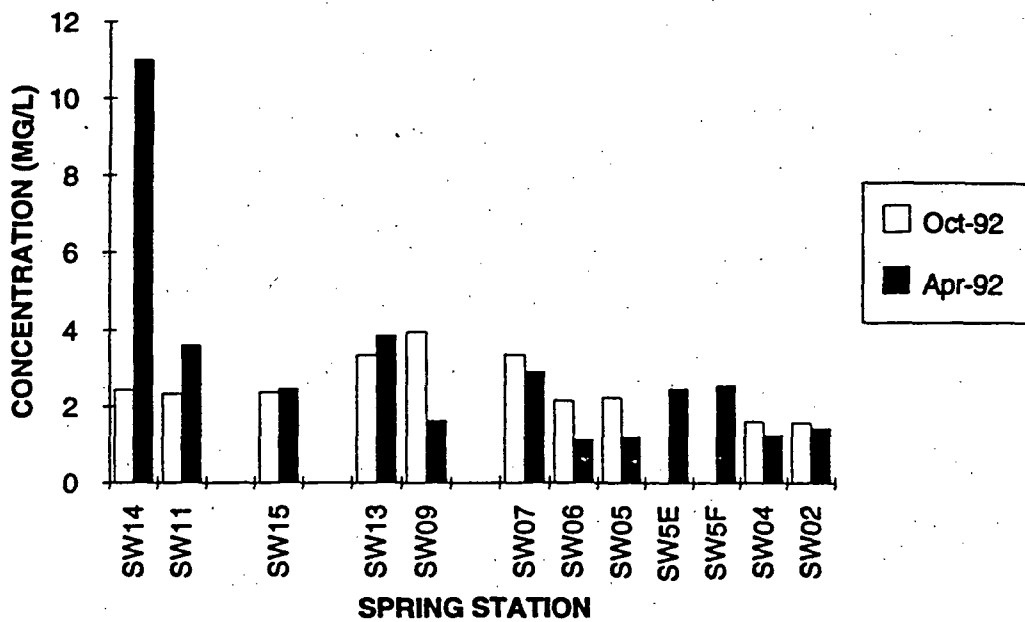
JOB No.

21372

DRAWING NO.

FIGURE 4.5-8

REV.



BECHTEL ENVIRONMENTAL, INC.
 SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Nitrate in
Surface Water and Groundwater



JOB No.

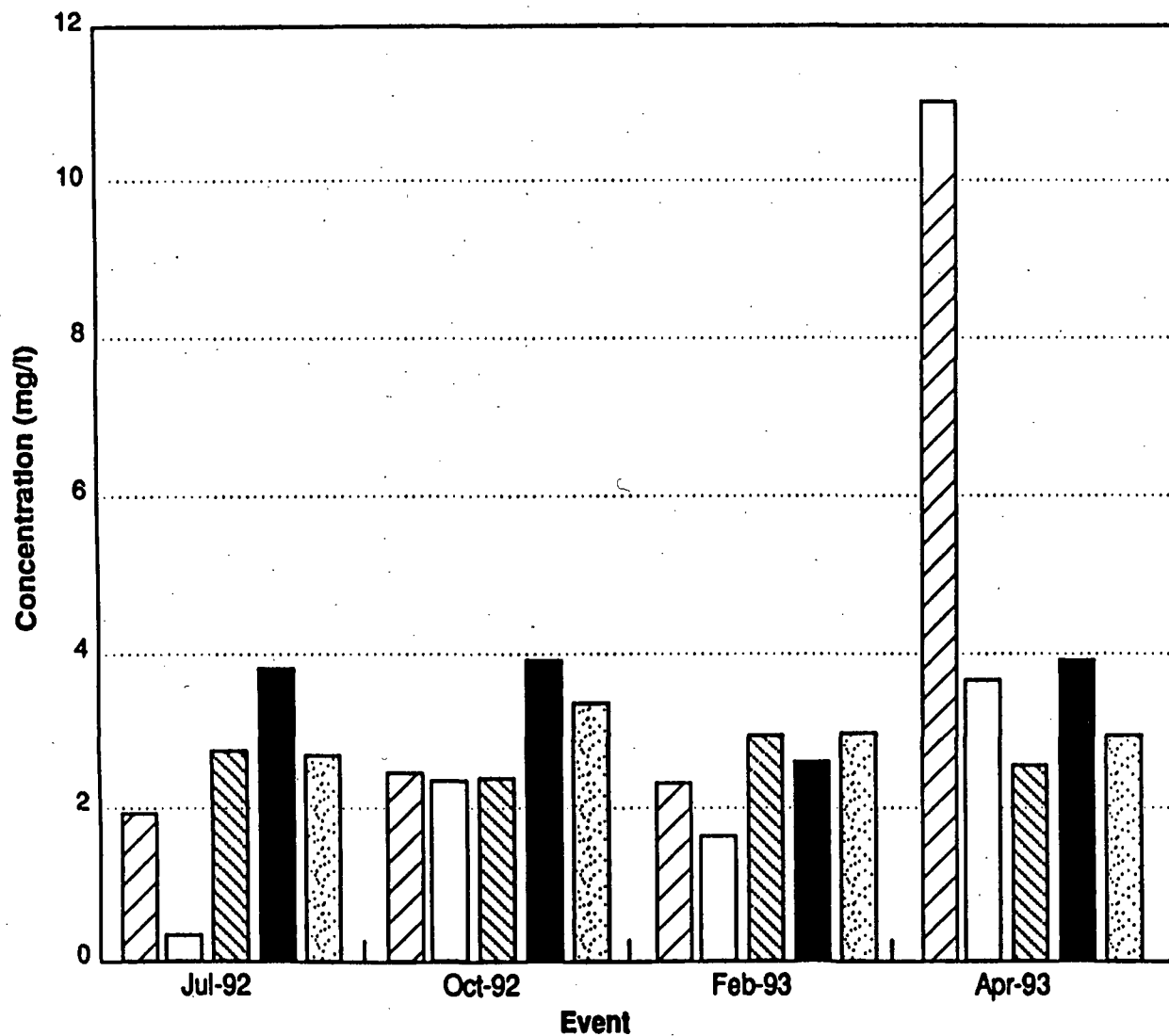
21372

DRAWING NO.

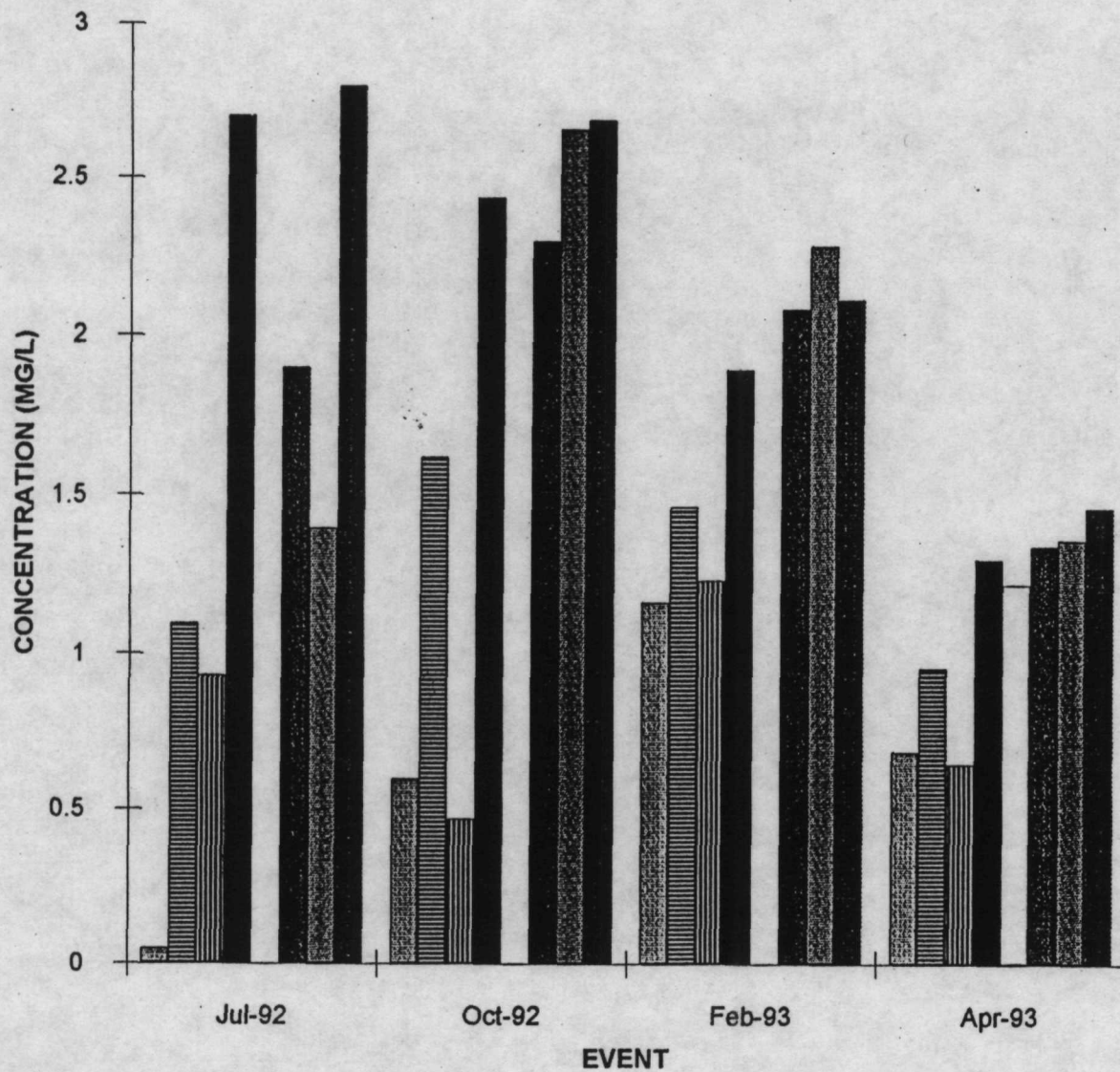
FIGURE 4.5-9

REV.

0



| | | |
|--|---------|---------------|
| BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO | | |
| EASTERN MICHAUD FLATS POCATELLO, IDAHO | | |
| Nitrate Concentrations for Springs over Four Quarters | | |
| | JOB No. | DRAWING NO. |
| | 21372 | FIGURE 4.5-10 |
| | | REV. |



Losing Reach:

- SW25 to SW18 (maximum)
- SW17 (below FMC Outfall)
- SW16

Gaining Reach:

- SW12 (below STP discharge)
- SW12E
- SW10
- SW08
- SW7E to SW01 (maximum)

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Nitrate Concentrations for
River Stations over Four Quarters



JOB NO.

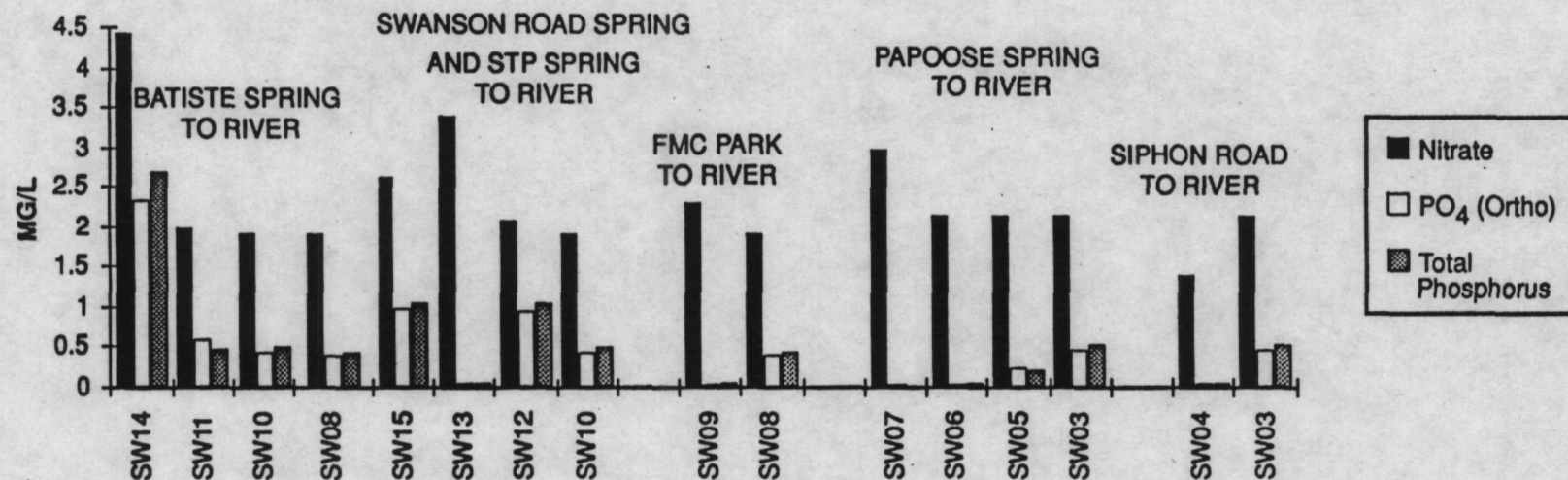
21372

DRAWING NO.

FIGURE 4.5-11

REV.

NUTRIENTS IN SPRING AND RIVER FLOW PATHS



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Nutrient Concentrations in Flowpaths
from Springs to Portneuf River



JOB No.

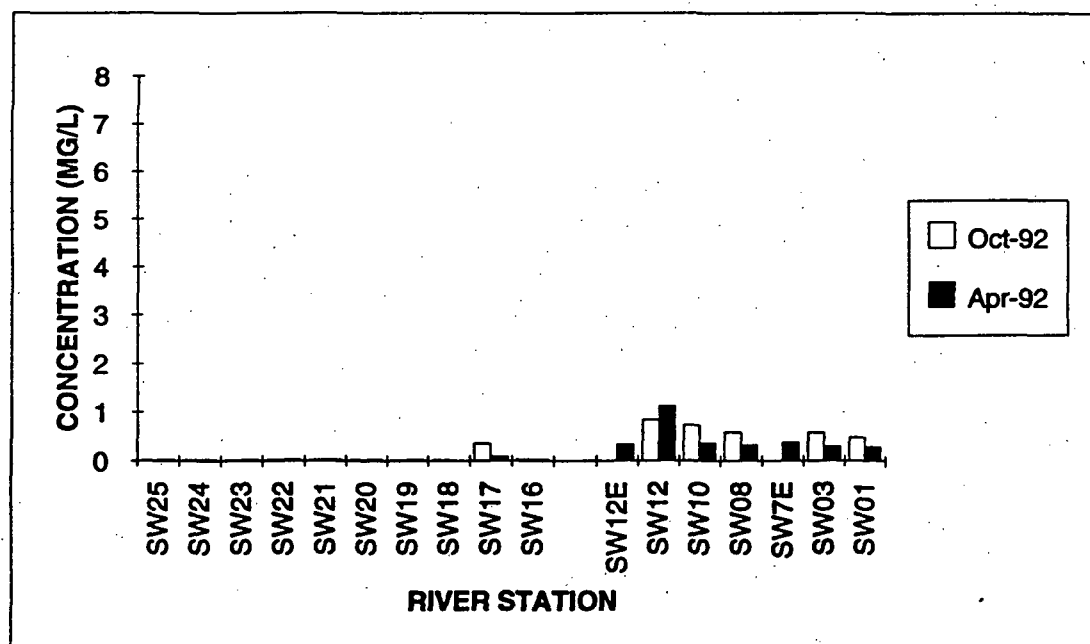
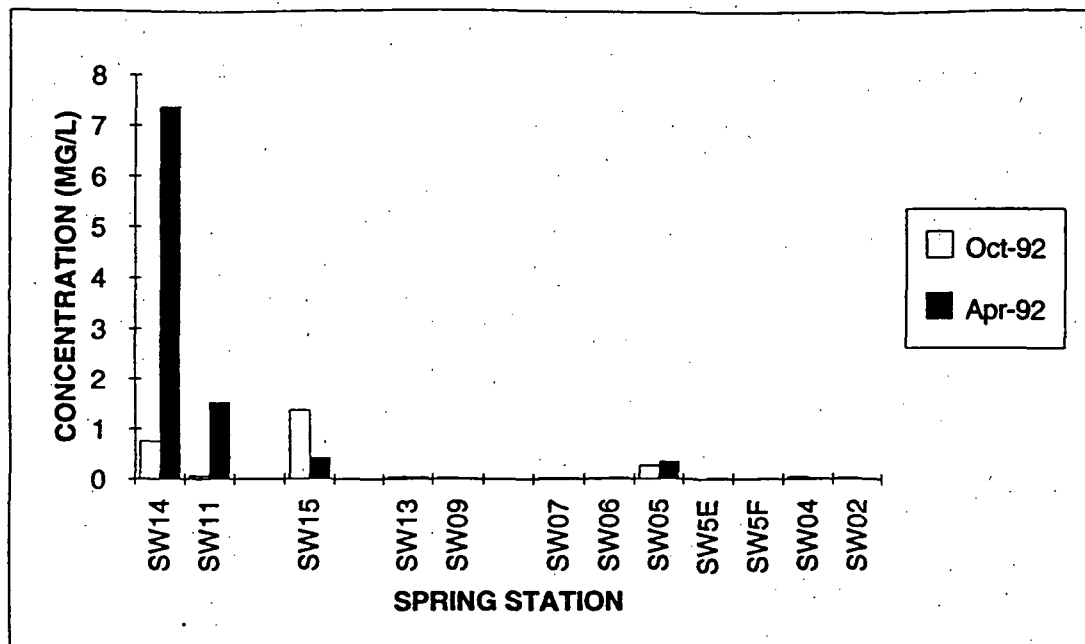
21372

DRAWING NO.

FIGURE 4.5-12

REV.

0



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Orthophosphate in
Surface Water and Groundwater



JOB No.

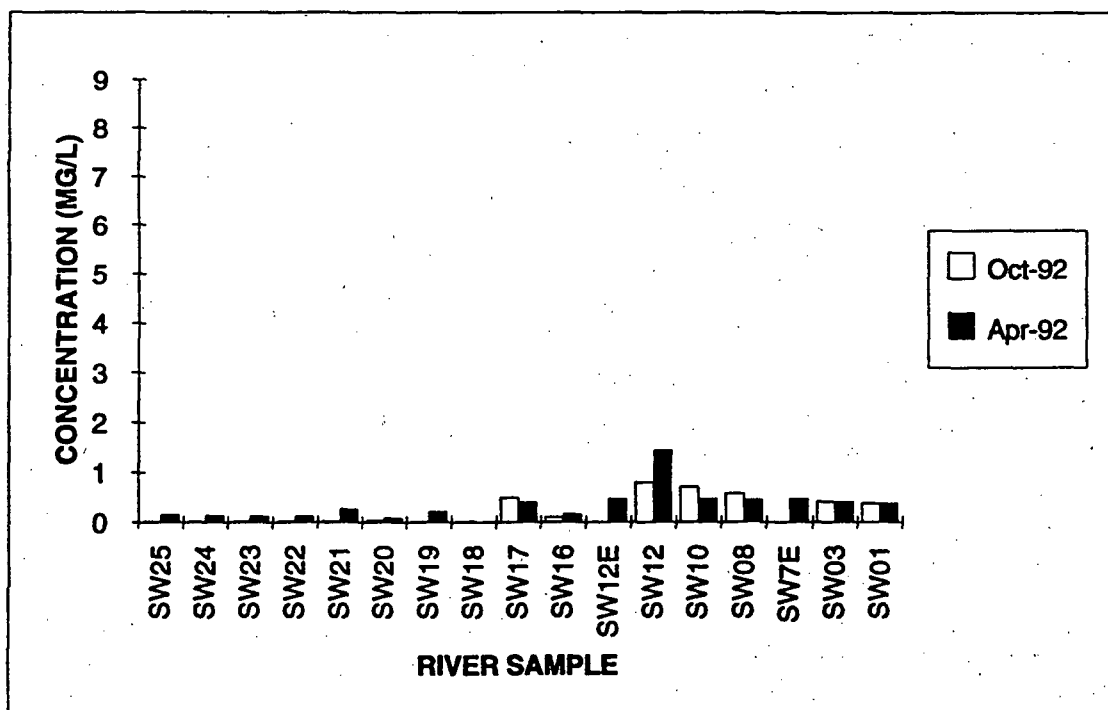
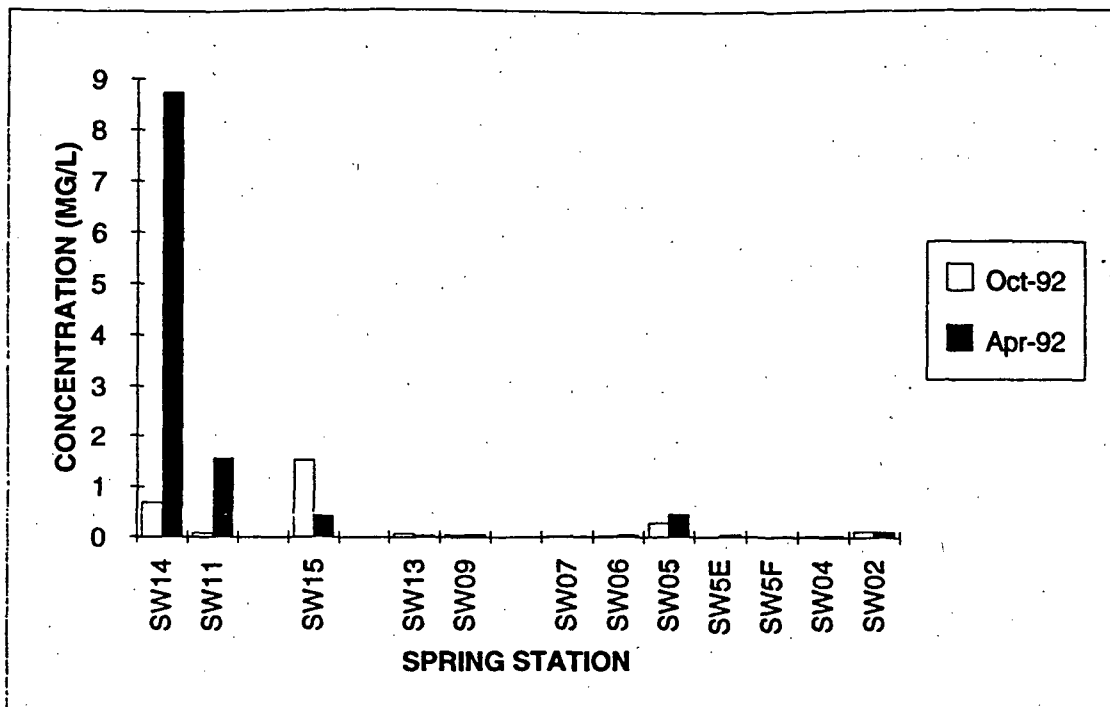
21372

DRAWING NO.

FIGURE 4.5-13

REV.

0



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Total Phosphorous in
Surface Water and Groundwater



JOB No.

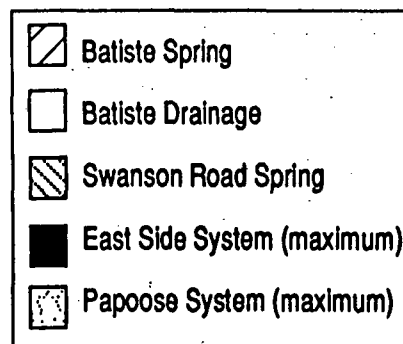
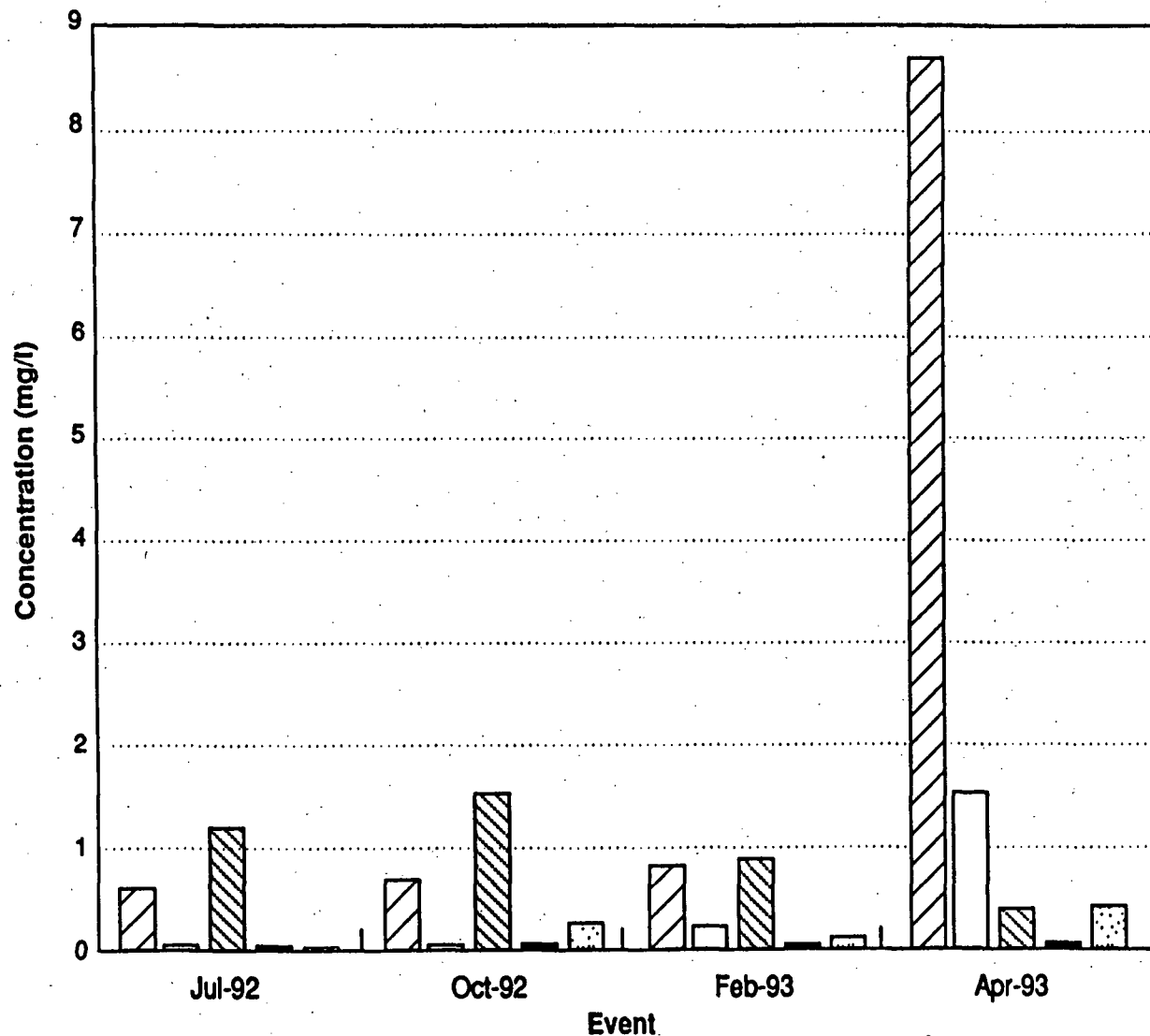
21372

DRAWING NO.

FIGURE 4.5-14

REV.

0



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Total Phosphorus Concentrations for
Springs over Four Quarters



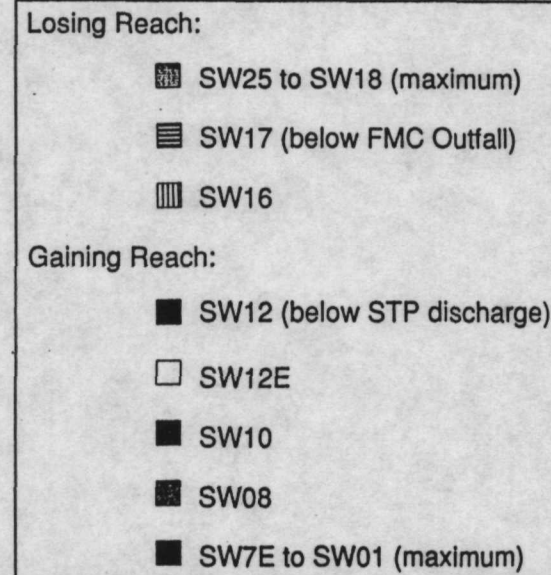
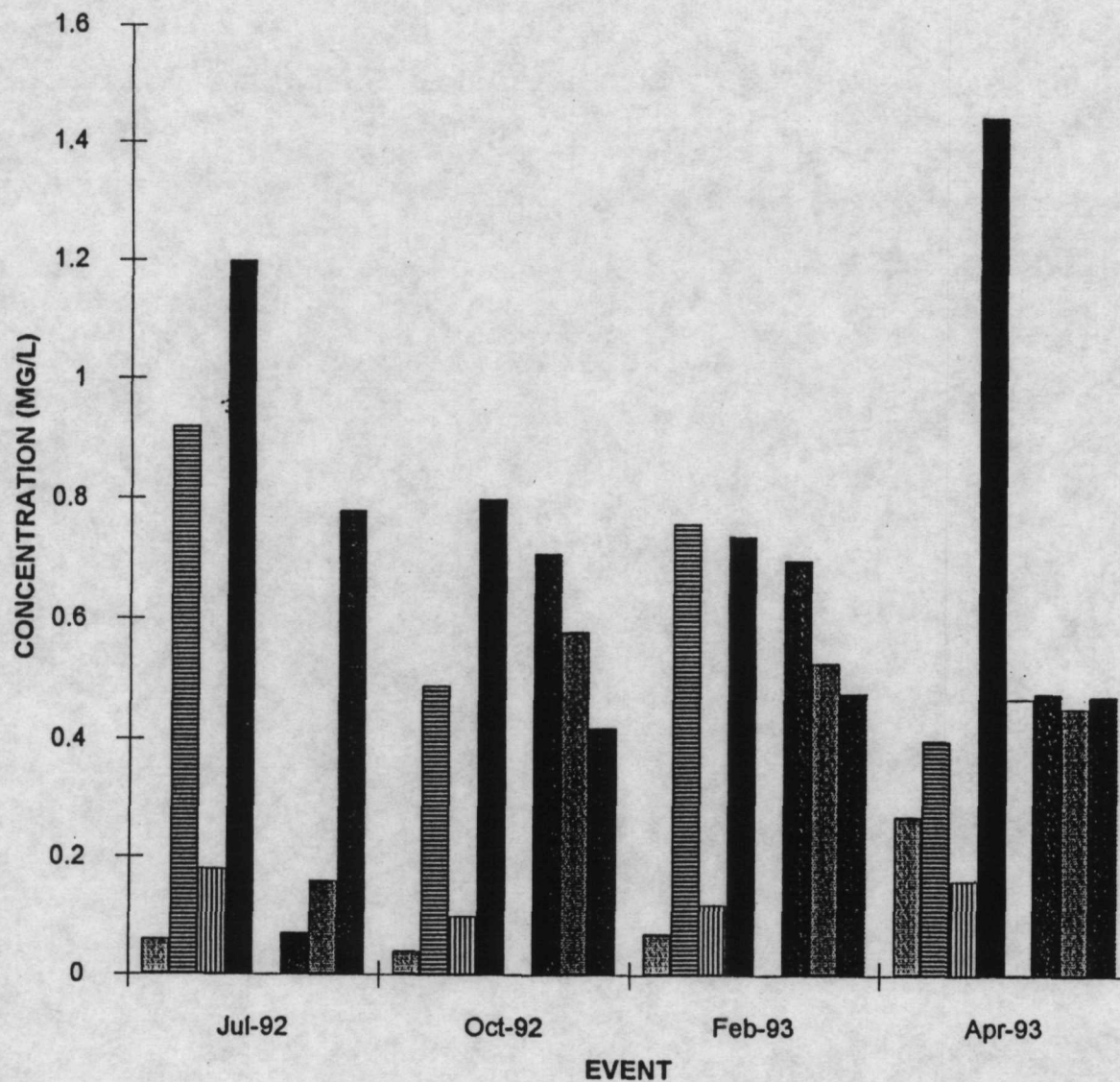
JOB No.

21372

DRAWING NO.

FIGURE 4.5-15

REV.



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Total Phosphorus Concentrations for
River Stations over Four Quarters



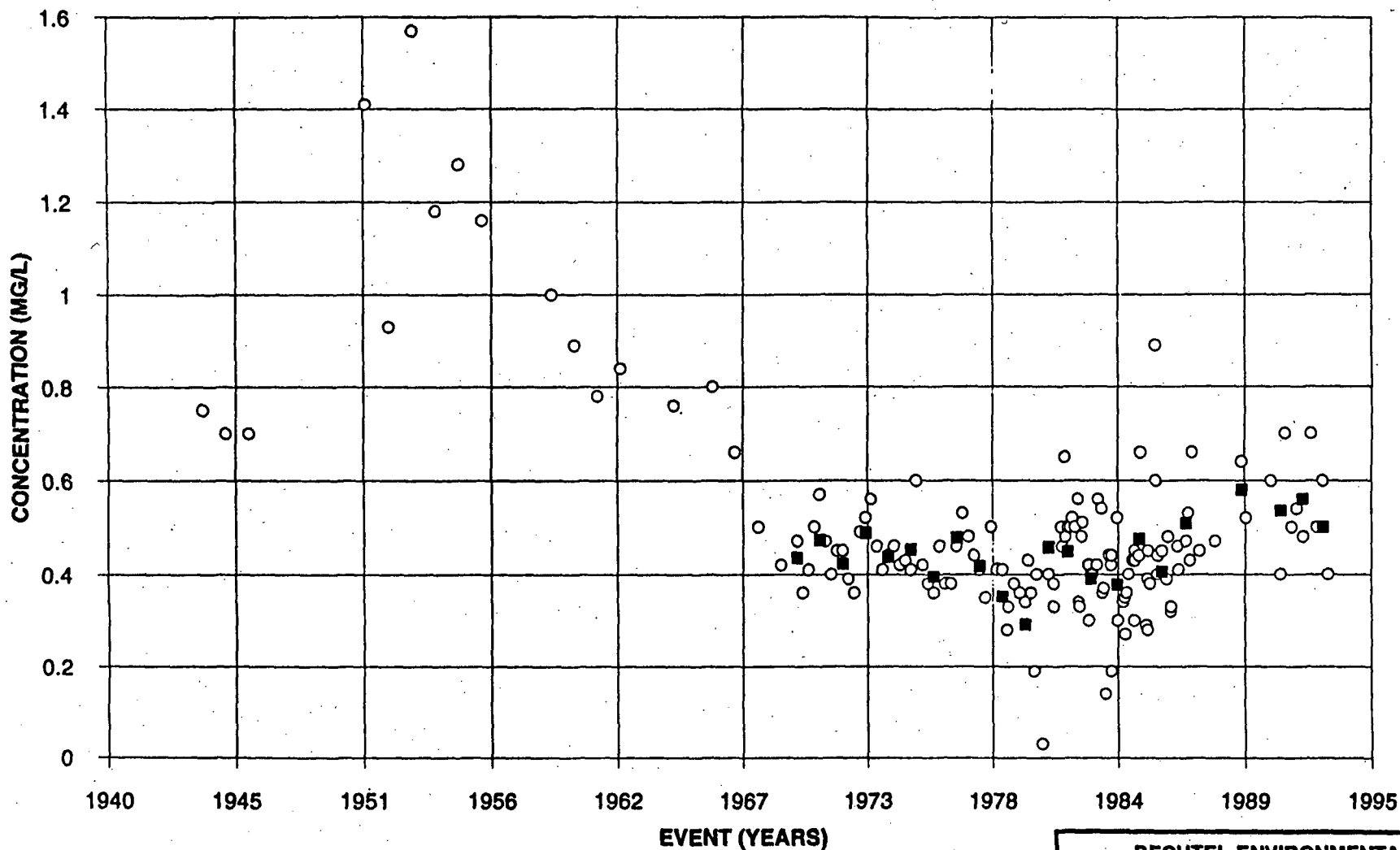
JOB No.

21372

DRAWING NO.

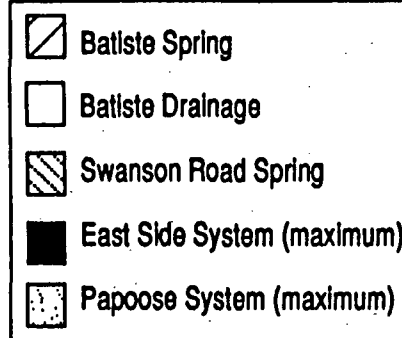
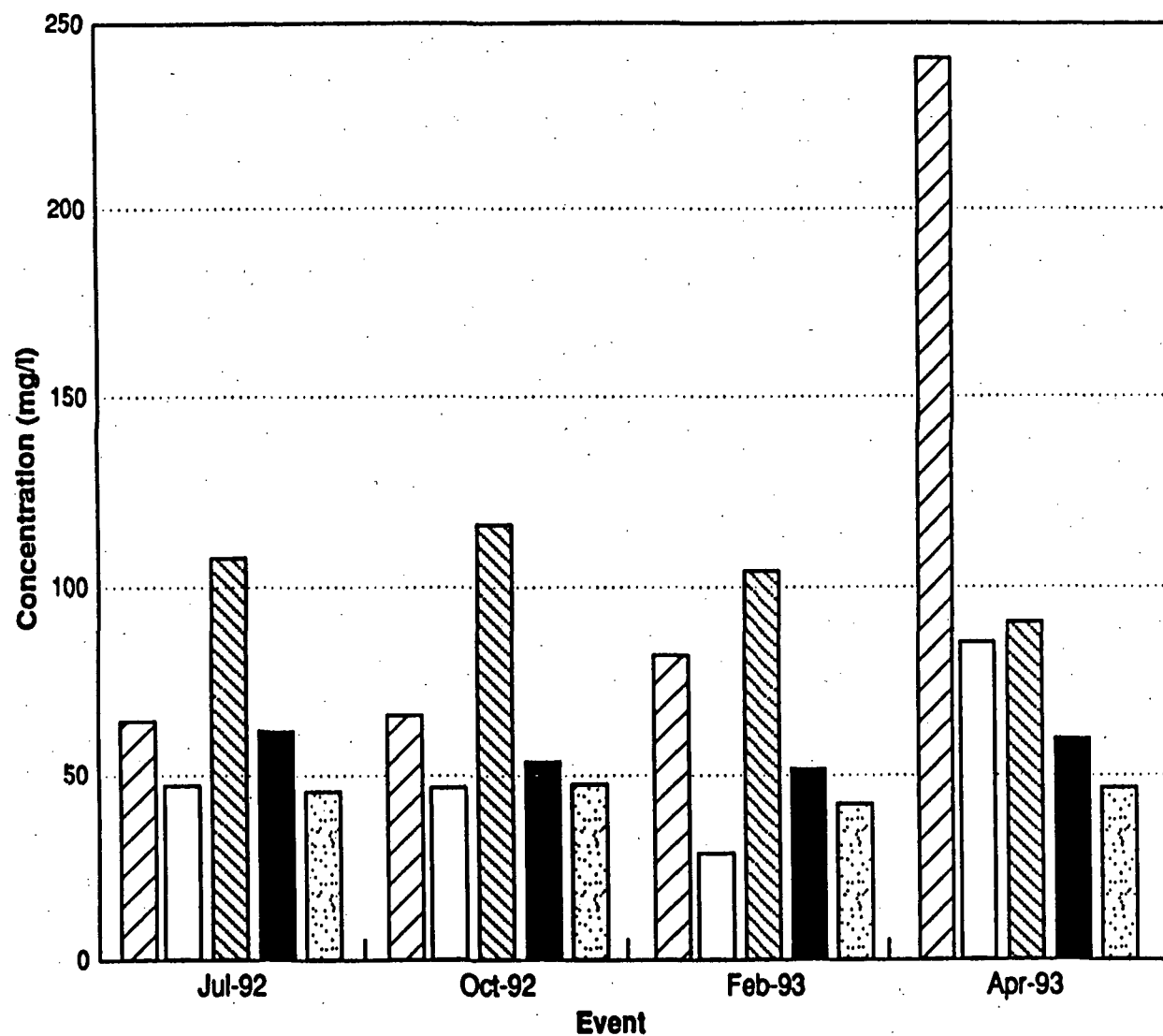
FIGURE 4.5-16

REV.



93-1477b.36

| | | | |
|--|---------|---------------|------|
| BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO | | | |
| EASTERN MICHAUD FLATS POCATELLO, IDAHO | | | |
| Historical Fluoride Concentration at Batiste Spring (1944-1993) | | | |
| | JOB No. | DRAWING No. | REV. |
| | 21372 | FIGURE 4.5-17 | |



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Sulfate Concentrations for
Springs over Four Quarters



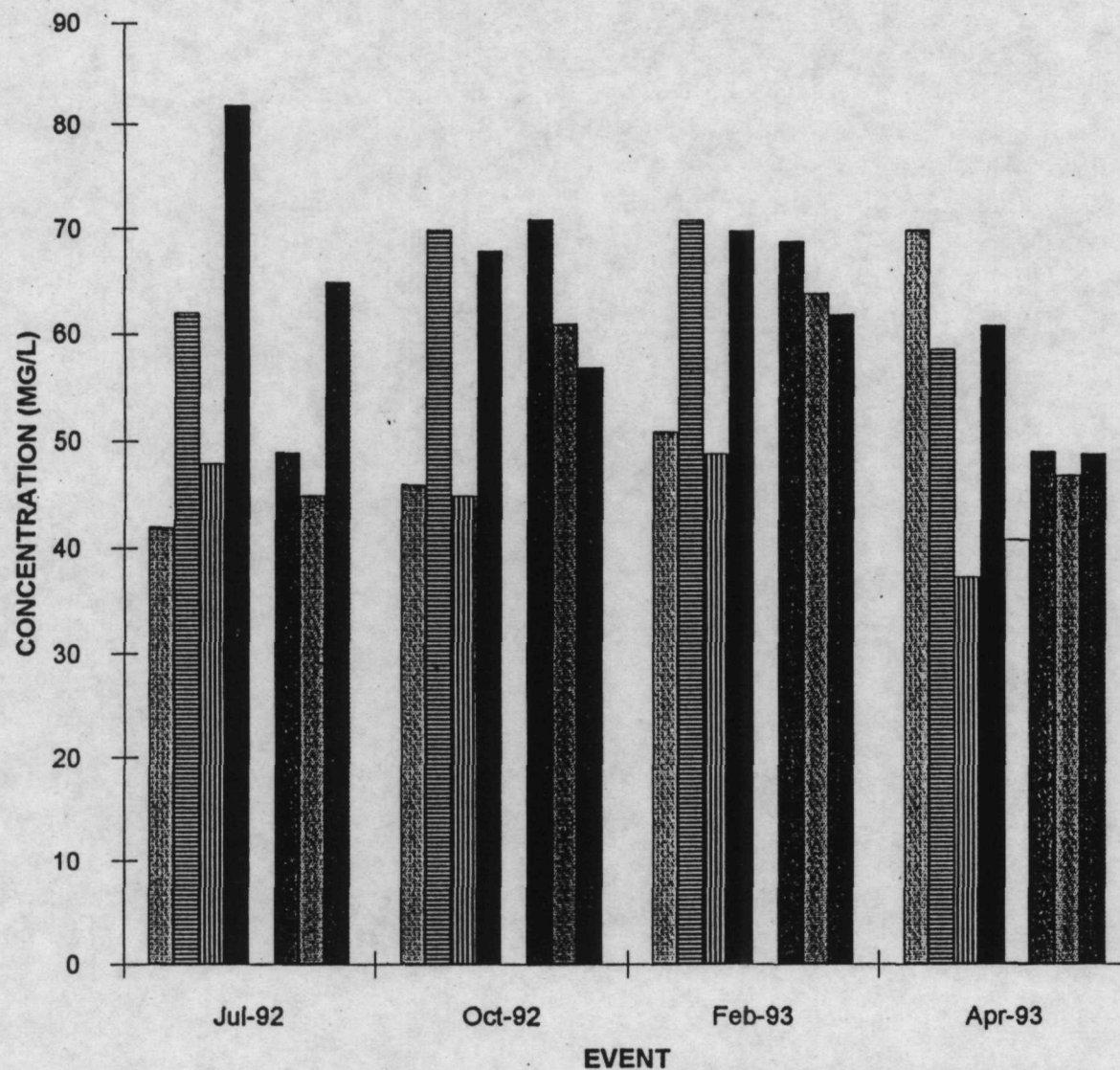
JOB No.

DRAWING NO.

REV.

21372

FIGURE 4.5-18



Losing Reach:

- SW25 to SW18 (maximum)
- SW17 (below FMC Outfall)
- SW16

Gaining Reach:

- SW12 (below STP discharge)
- SW12E
- SW10
- SW08
- SW7E to SW01 (maximum)

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Sulfate Concentrations for
River Stations over Four Quarters



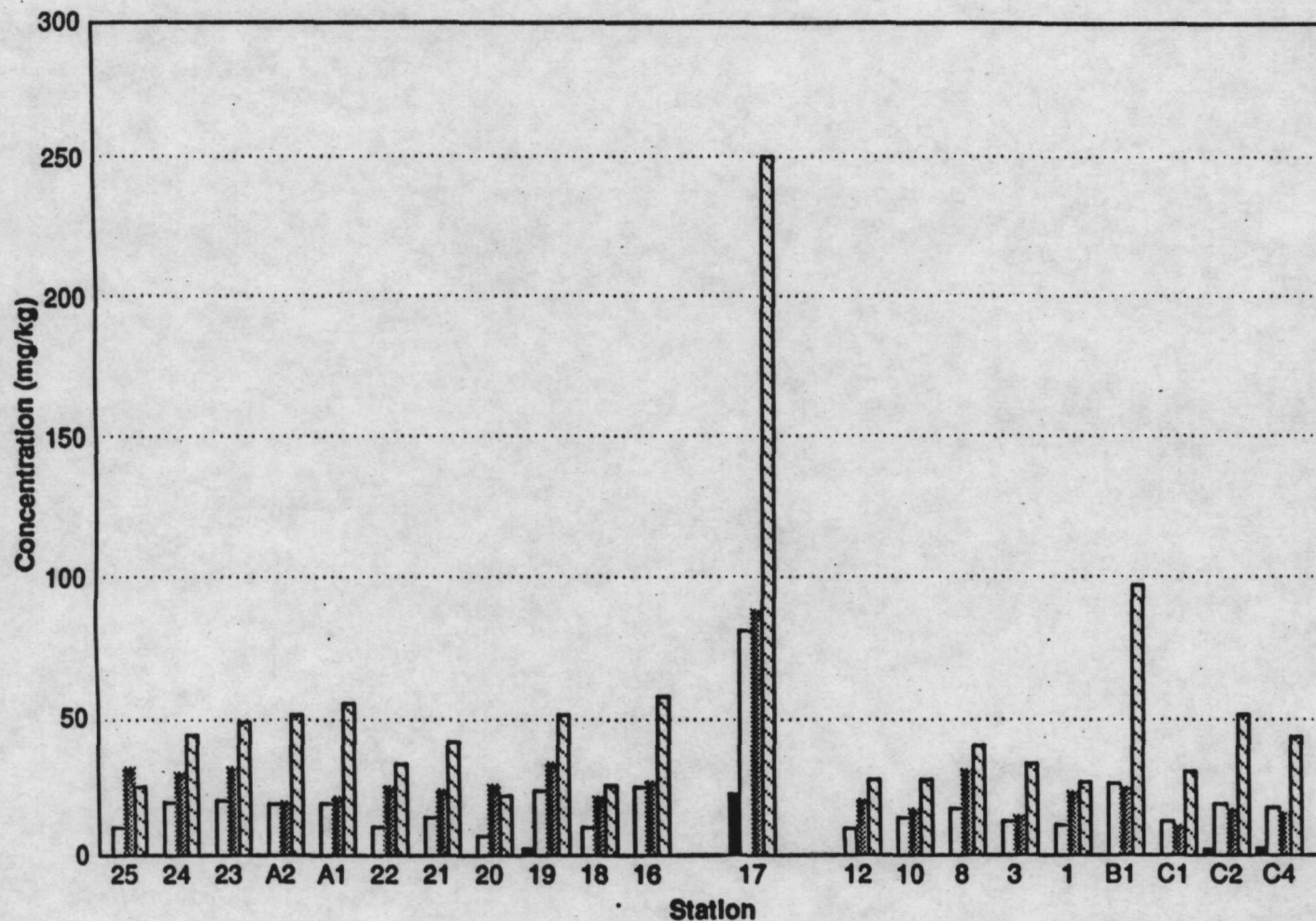
JOB No.

21372

DRAWING NO.

FIGURE 4.5-19

REV.



| | Representative Levels (mg/kg) | |
|-----------------|-------------------------------|---------------|
| | Subsurface Soils | Surface Soils |
| Cadmium | 1.2 | 4.9 |
| Chromium, total | 27 | 53 |
| Vanadium | 53 | 35 |
| Zinc | 52 | 90 |

| | |
|---|-----------------|
| ■ | Cadmium, total |
| □ | Chromium, total |
| ▨ | Vanadium, total |
| ▧ | Zinc, total |

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Indicator Metals in
Sediments for River Sampling Stations



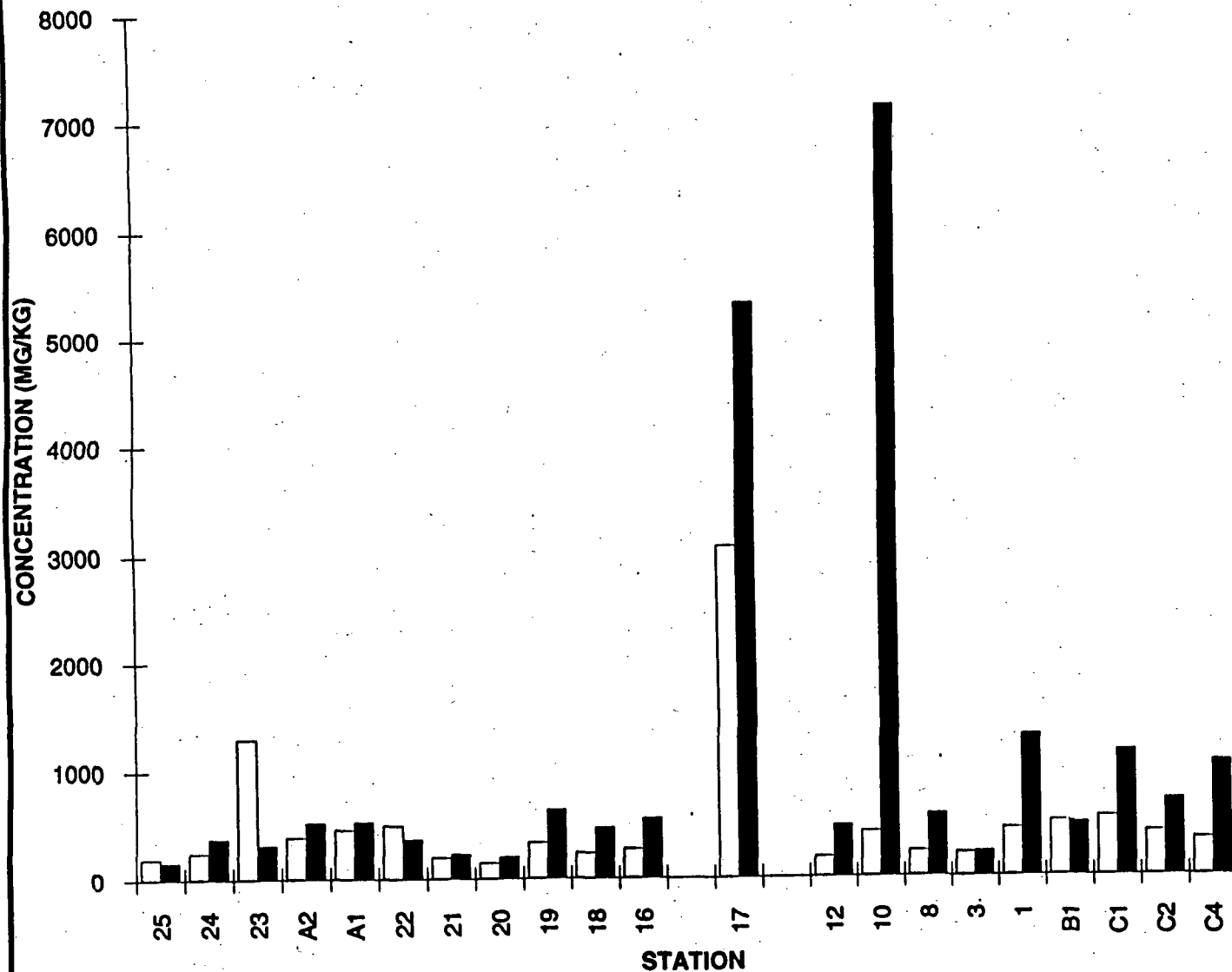
JOB No.

21372

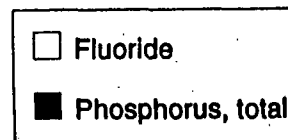
DRAWING NO.

FIGURE 4.5-20

REV.



| | Representative Levels (mg/kg) | |
|-------------------|-------------------------------|---------------|
| | Subsurface Soils | Surface Soils |
| Fluoride | 559 | 658 |
| Phosphorus, Total | 840 | 1,512 |



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Total Phosphorus
and Fluoride in River Sediments



JOB No.

21372

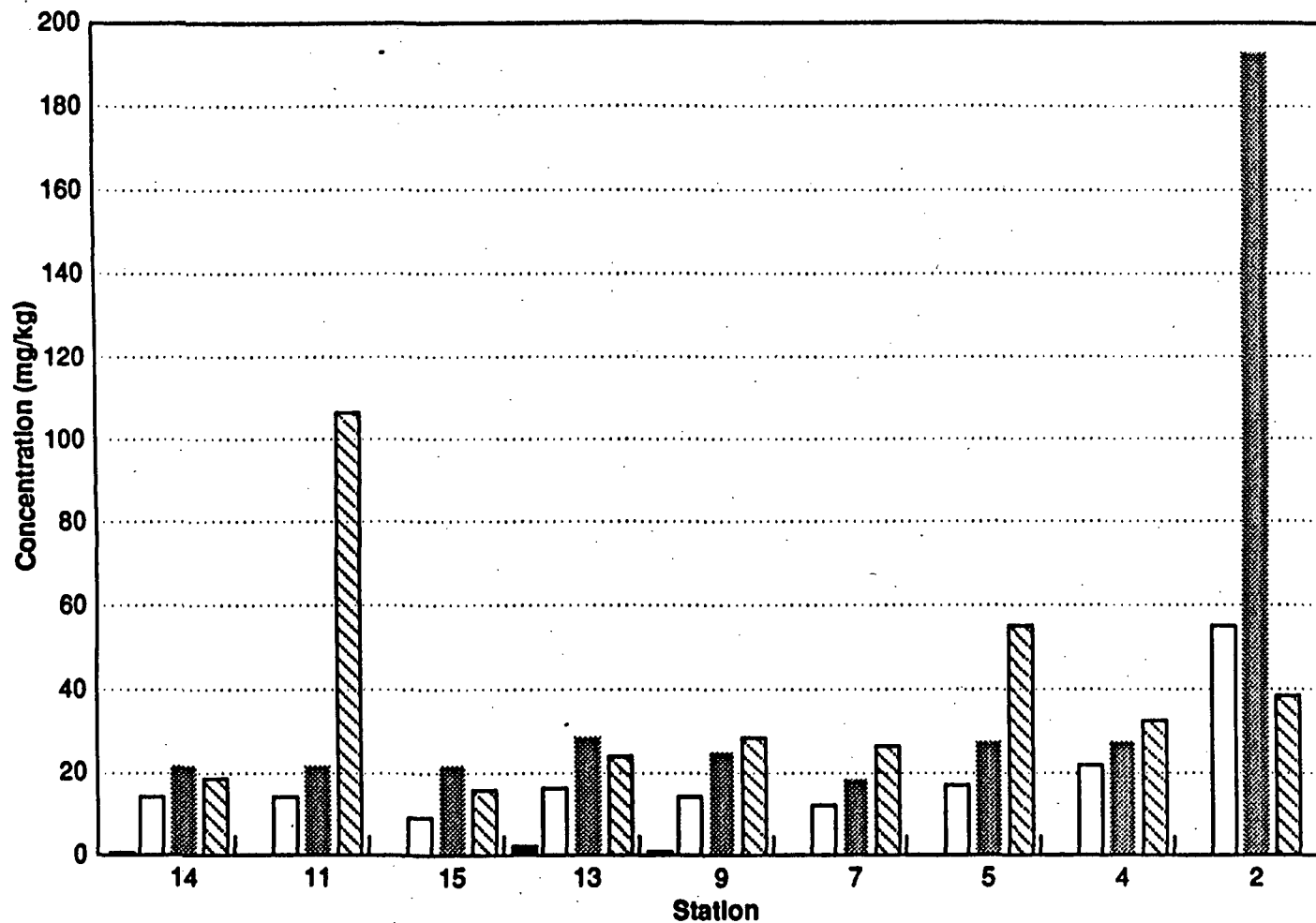
DRAWING NO.

FIGURE 4.5-21

REV.

Losing

Gaining



| | Representative Levels (mg/kg) | |
|-----------------|----------------------------------|------------------|
| | Subsurface Soils | Surface Soils |
| Cadmium | 1.2 | 4.9 |
| Chromium, total | 27 | 53 |
| Vanadium | 53 | 35 |
| Zinc | 52 | 90 |

| | |
|---|-----------------|
| ■ | Cadmium, total |
| □ | Chromium, total |
| ▨ | Vanadium, total |
| ▧ | Zinc, total |

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Indicator Metals
in Spring Sediments



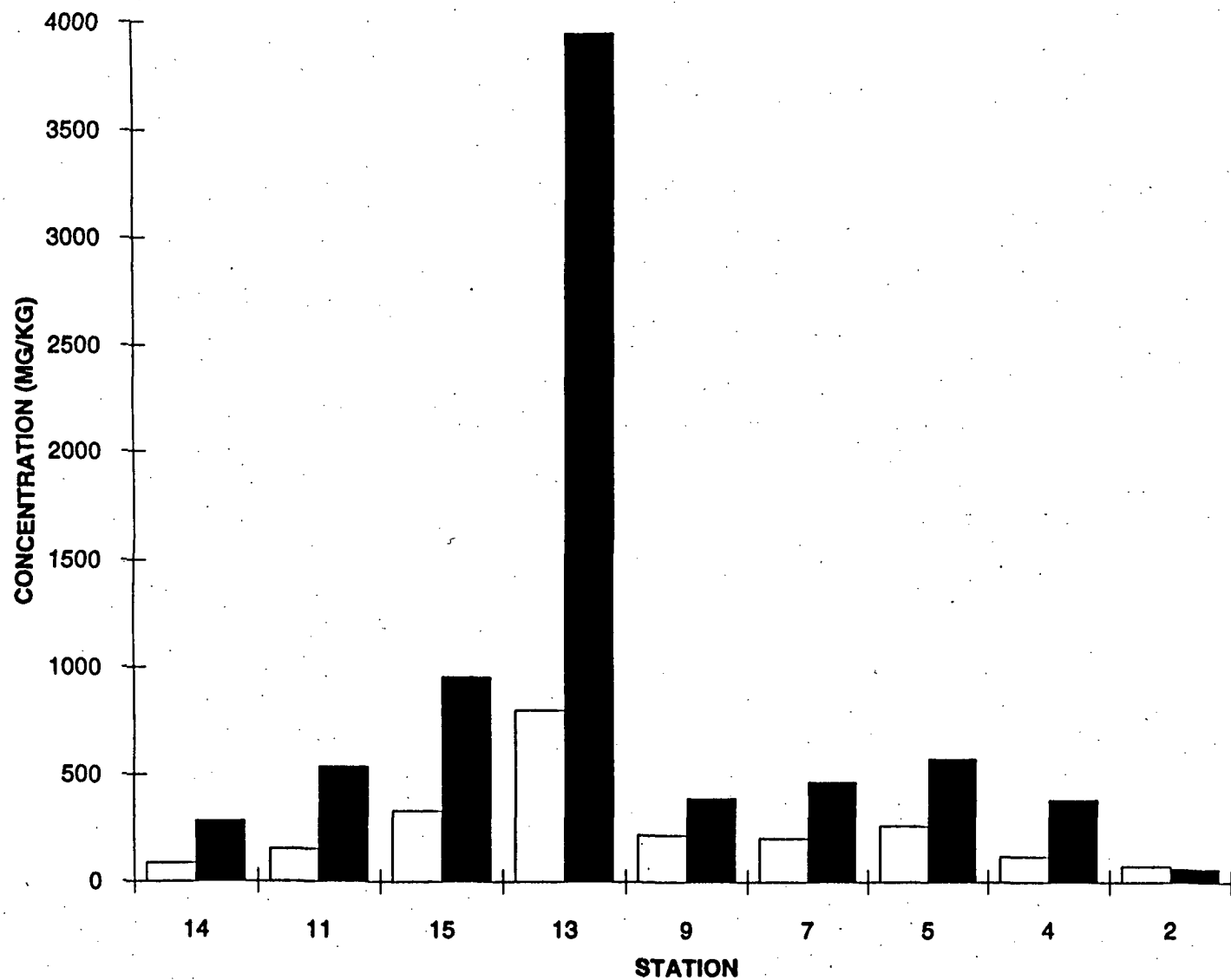
JOB No.

21372

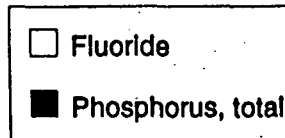
DRAWING NO.

FIGURE 4.5-22

REV.



| | Representative Levels (mg/kg) | |
|-------------------|----------------------------------|------------------|
| | Subsurface Soils | Surface Soils |
| Fluoride | 559 | 656 |
| Phosphorus, Total | 840 | 1,512 |



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

**Concentrations of Total Phosphorus
and Fluoride in Spring Sediments**



JOB No.

21372

DRAWING NO.

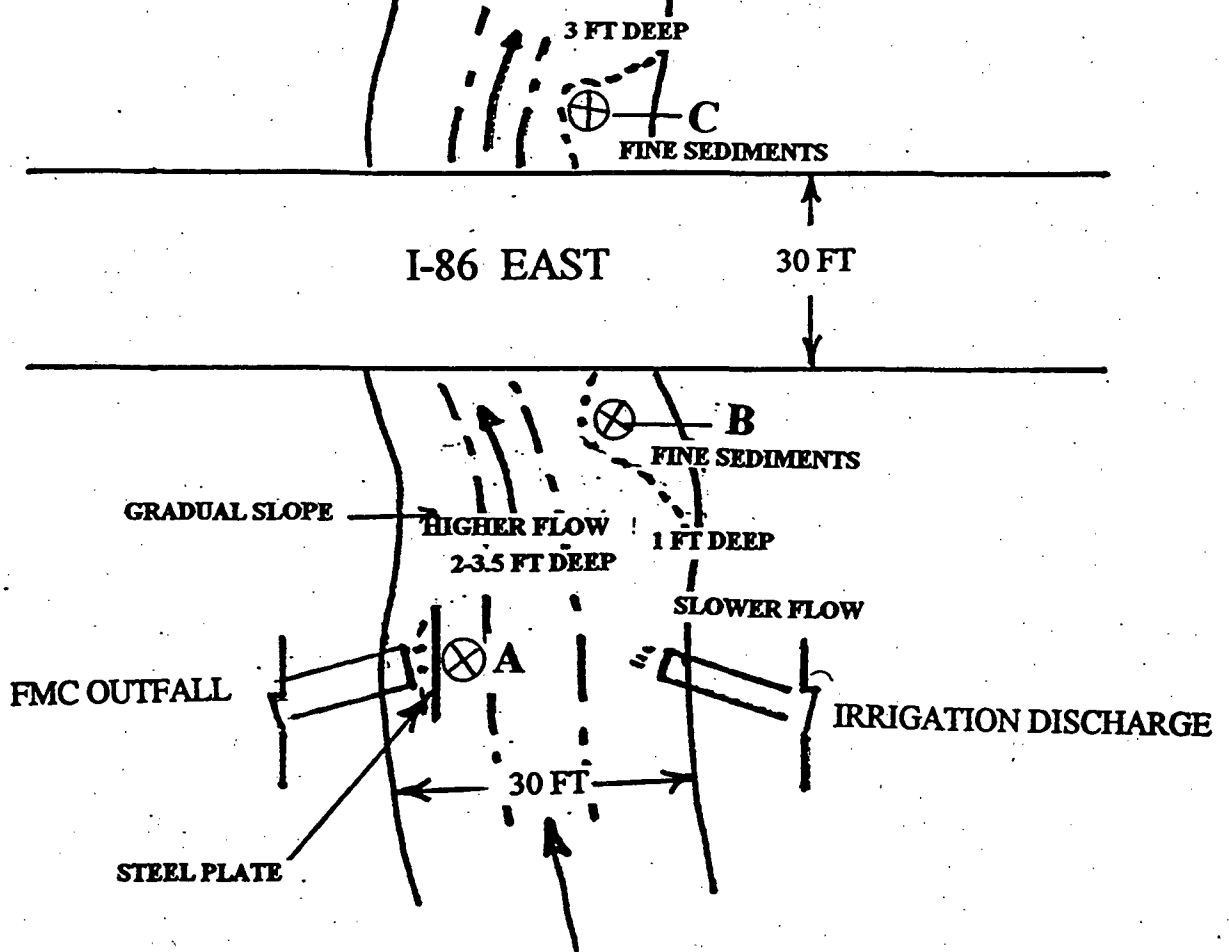
FIGURE 4.5-23

REV.

PORTNEUF RIVER

I-86 WEST

I-86 EAST



NOT TO SCALE



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Locations of Phase II FMC
Outfall Samples



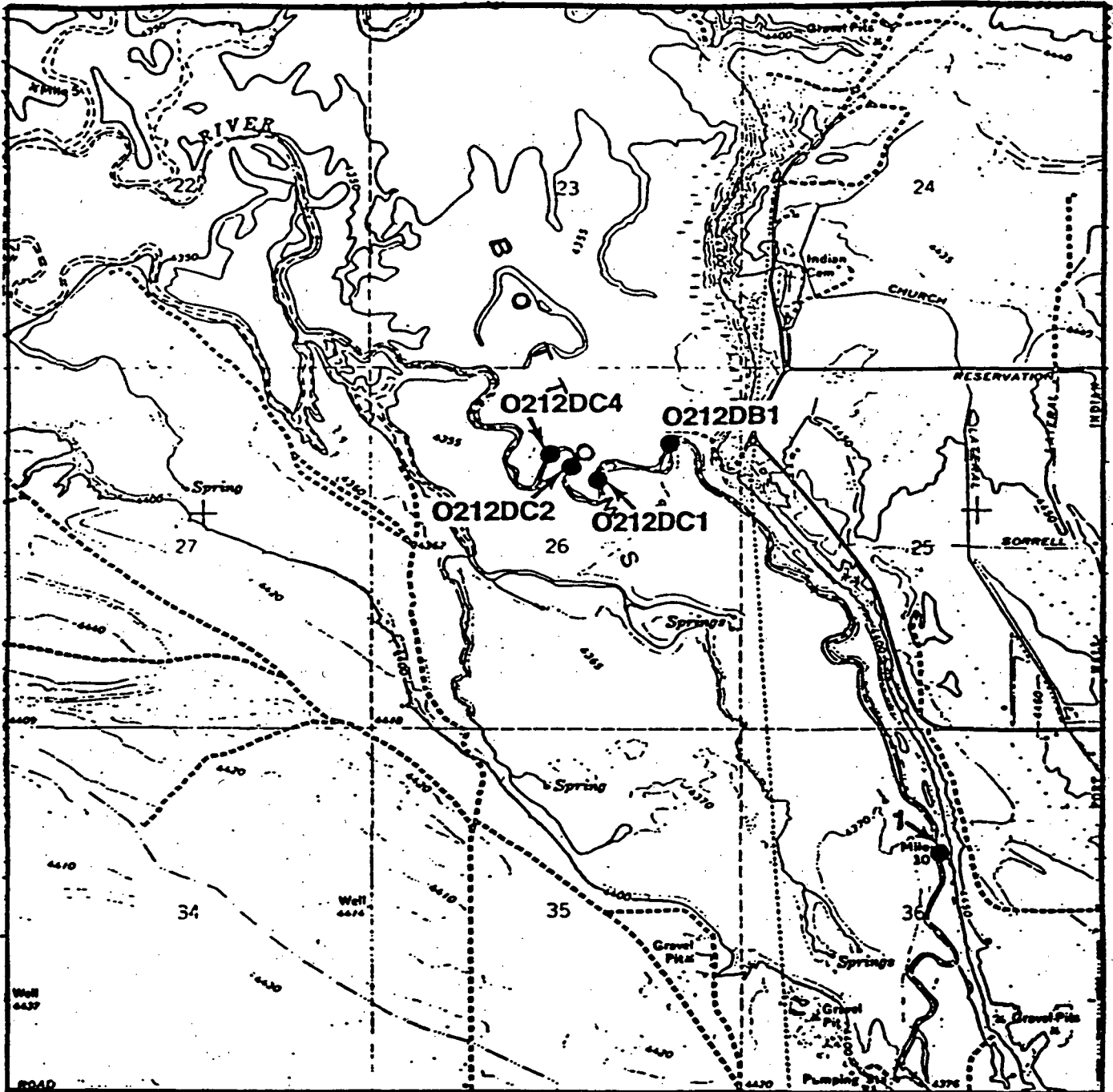
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DRAWING NO.

REV.

21372

FIGURE 4.5-24



SCALE 1:24 000



CONTOUR INTERVAL 10 FEET



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Sediment Samples Taken in the
Fort Hall Bottoms



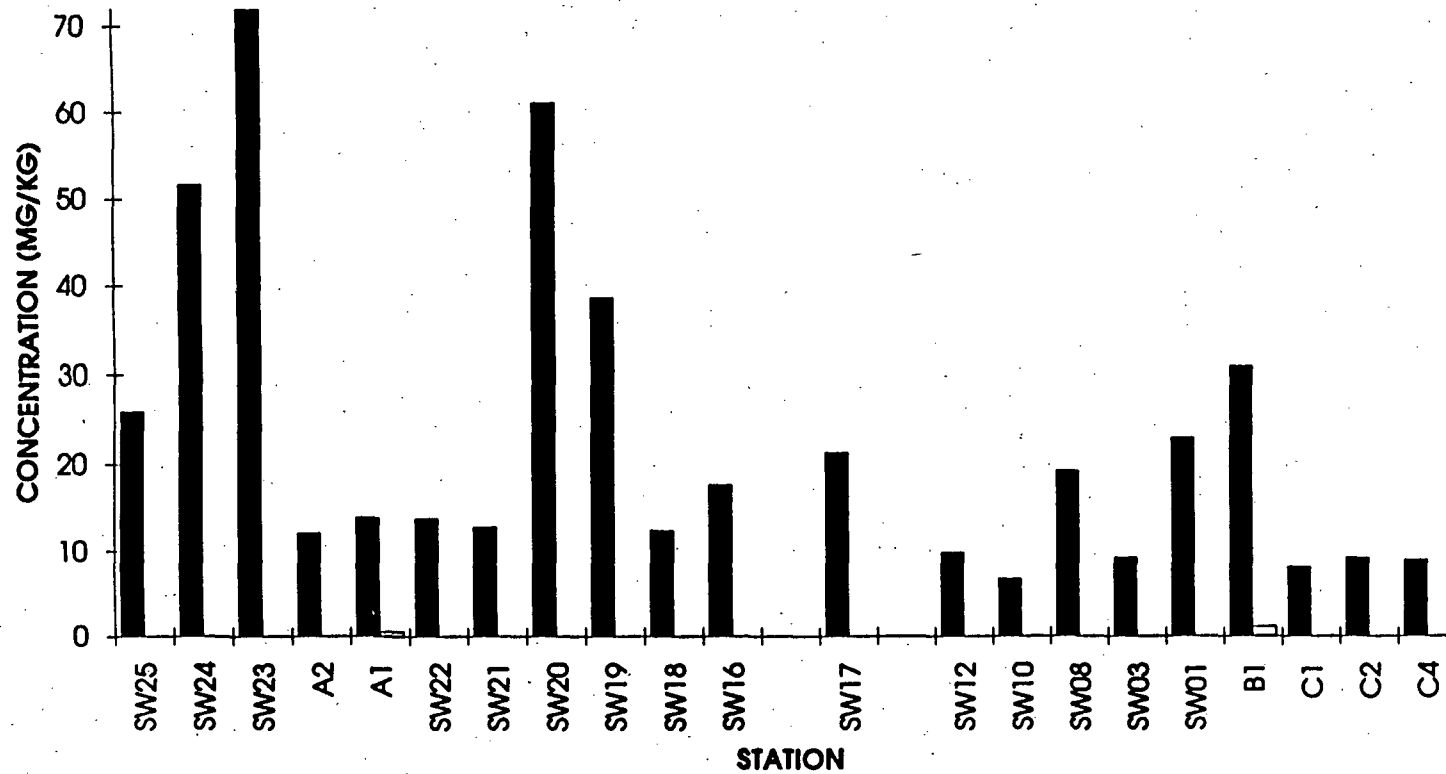
JOB No.

21372

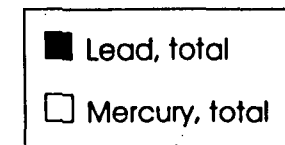
DRAWING NO.

FIGURE 4.5-25

REV.



| | Representative Levels (mg/kg) | |
|---------|-------------------------------|---------------|
| | Subsurface Soils | Surface Soils |
| Lead | 26 | 36 |
| Mercury | 0.33 | 0.23 |



Losing

Gaining

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Lead and Mercury in
Sediments for River Sampling Stations



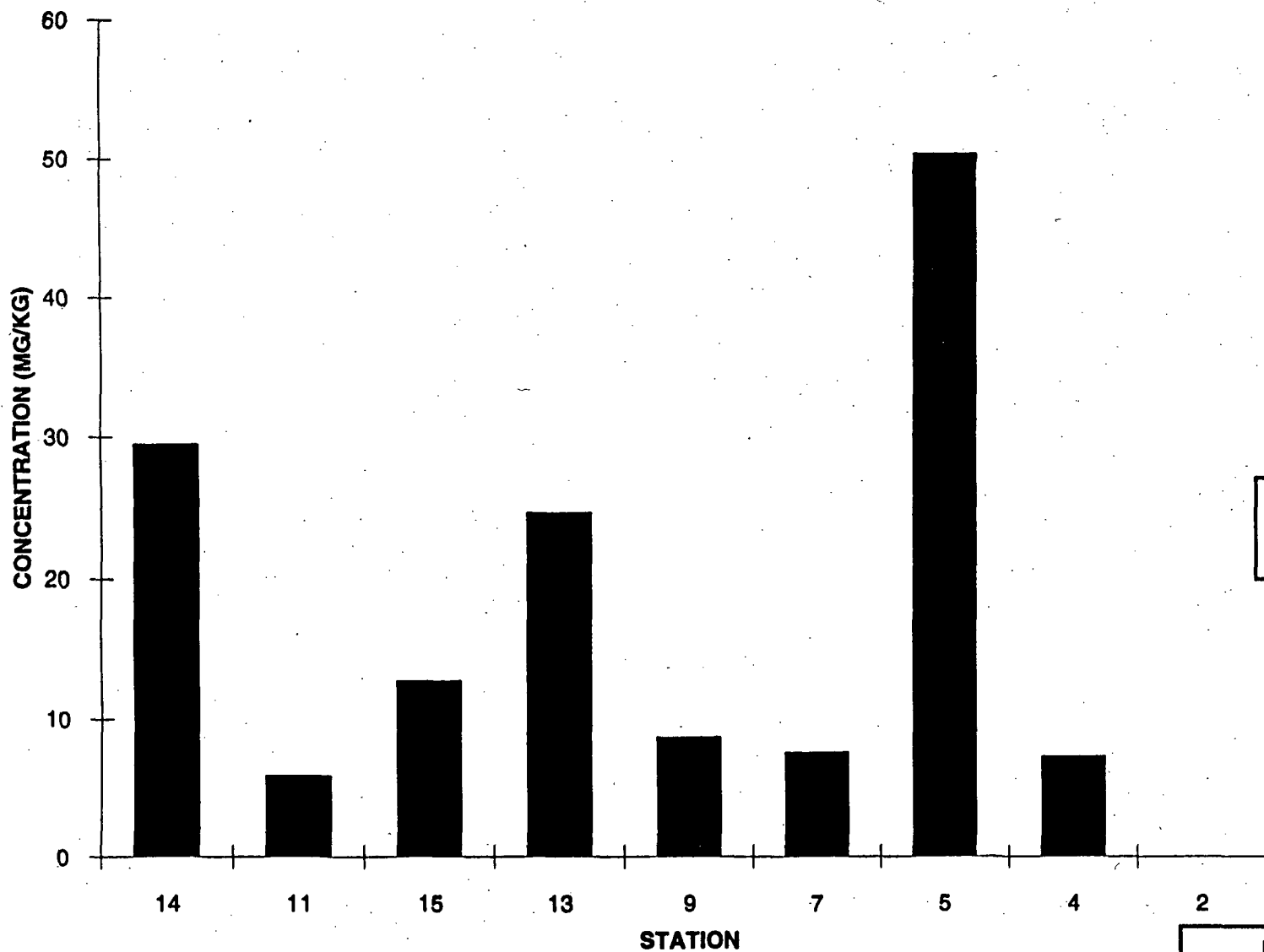
JOB No.

21372

DRAWING NO.

FIGURE 4.5-26

REV.



Note: Representative level for lead in subsurface soils is 26 mg/kg; in surface soils, it is 36 mg/kg.

■ Lead, total

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Lead in
Spring Sediments



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DRAWING NO.

FIGURE 4.5-27

REV.

Section 5

Summary

The Eastern Michaud Flats (EMF) facilities area encompasses approximately 2,600 acres in Power and Bannock counties, Idaho. Its eastern boundary is approximately 2.5 miles northwest of Pocatello, Idaho. Within the EMF area are two adjacent operating phosphate ore processing facilities, the FMC Corporation Elemental Phosphorus Plant (FMC) and the J.R. Simplot Company Don Plant (Simplot).

The EMF site was listed on the National Priority List on August 30, 1990. Under an EPA Administrative Order on Consent (AOC) issued in April 1991, a remedial investigation (RI) was begun in April 1992. Two phases of investigations have been concluded. These consist of characterization of offsite soil, potential sources and onsite soils, surface water and sediments, and groundwater, demography, and ecology. The results of these investigations, which were completed in the summer of 1993, have been combined with previous investigation results to yield this Preliminary Site Characterization Summary (PSCS). An ongoing study of the fate and transport of fugitive dust and industrial stack emissions will be presented as a supplemental report. Further investigation of ecological resources is being planned; when completed, the results will also be presented in a supplemental report.

The purpose of the PSCS is to:

- Present and interpret physical data collected during the field investigations and use these data to describe the potential pathways for migration of constituents of potential concern.
- Describe the constituents of potential concern and their distribution in groundwater, surface water, soils, and sediments using the results of laboratory analyses of environmental samples collected during the field investigation.
- Furnish data for use in the baseline risk assessment.
- Furnish data for use in identifying potential remedial action objectives.
- Provide a technical foundation and source of information for feasibility studies of potential remedial action alternatives.

This summary provides, first, a physical depiction of the EMF study area (Section 5.1), followed by a summary of the scope and results of the site investigations (Section 5.2).

5.1 PHYSICAL CHARACTERIZATION

This section summarizes information on the location, geology, surface water hydrology, groundwater hydrology, soils, climate, demography, and ecology of the EMF study area. A detailed description of these topics is presented in Section 3 of the PSCS.

5.1.1 Location

The EMF study area is located at the base of the northern slope of the Bannock Range, where it merges with the Snake River Plain (see Figures 1-2 and 1.3-1). The northern part of the EMF study area is located at the southeastern edge of Michaud Flats, a relatively flat plain situated between the American Falls Reservoir and the base of the Bannock Range. The southern part of the EMF study area extends onto the north slope of the Bannock Range. The base of this slope, where it meets the relatively level plain of Michaud Flats, is characterized by a curving, gently sloping erosional scarp some 50 to 70 feet high.

The Portneuf River passes the EMF study area on the northeast, and the intermittent Michaud Creek passes to the west. The floodplain of the Portneuf River at the northeastern margin of the EMF study area is about 0.5 mile wide. Several steep, dry draws extending up the slopes of the Bannock Range in the southern portion of the EMF study area.

5.1.2 Geology

The stratigraphy of the EMF study area can be generally described as a series of discontinuous layers of unconsolidated sediments deposited on an erosional surface that was incised in volcanic bedrock. Figure 3.1-3 illustrates the general stratigraphy of the area. The sedimentary unit immediately above the bedrock is a gravel derived from volcanic rocks. Most of the site's "deep" monitoring wells are in this gravel unit, which is part of the Sunbeam Formation.

Overlying the gravels in much of the study area are varying thicknesses of fine-grained silts, clays, and sands that form a discontinuous, semi-confining unit. This unit (called the American Falls Lake Beds Formation) is absent in the northern part of the Simplot facility and in the eastern part of the FMC facility. Above this fine-grained unit is another coarse-grained unit that consists of quartzite, chert, and volcanic gravel, cobbles, and boulders. This unit, known as the Michaud gravels, was deposited during the Bonneville flood approximately 15,000 years ago. Most of the "shallow" monitoring wells installed in the study area are completed in this unit.

Section 5 Summary

Above the second gravel unit is another fine-grained unit that consists of interfingering silts, clays, and sands. This unit is typically saturated in its lower half. In the western part of the site, a separate but discontinuous third coarse-grained layer is present. This unit is generally unsaturated. Finally, deposits of windblown silt (loess) and a colluvial silt layer of variable thickness mantle the study area. The loess layer ranges from 2 to over 100 feet thick in the EMF study area. It is calcareous, and testing performed on numerous soil samples indicates it has a pH ranging between 7 and 10, with the mean being approximately 8.

To the north and east, the Michaud gravels occur in scoured channels. The Portneuf River flows in a valley within these gravels. The fine-grained layers present in the western and central areas of the site are generally absent here.

5.1.3 Surface Water Hydrology

There are no unpermitted or natural surface water flows within operations and waste management areas of the FMC and Simplot facilities. Therefore, characterization of potential pathways for constituent migration via surface waters consisted of:

- Analysis of the potential for stormwater to leave the FMC and Simplot facilities by overland and point source runoff under potential storm conditions: the maximum 24-hour-period storm recorded in Pocatello and a 2-year storm.
- Evaluation of sediment transport and deposition patterns in the Portneuf River, and the relative sediment contributions of the Portneuf and Snake rivers to the American Falls Reservoir.
- Analysis of constituent concentrations in the water and sediment of the FMC industrial wastewater (IWW) ditch. This ditch is permitted to discharge noncontact cooling water to the Portneuf River.

The stormwater analysis found that, based on the current topography, all precipitation accumulates within a series of drainage basins and is retained within the FMC and Simplot facilities under both the maximum recorded and the 2-year storms. Stormwater will not be discharged to the Portneuf River. This analysis confirmed previous assessments and was supported by field reconnaissance. These observations and discussions with FMC and Simplot personnel indicate that there are no point source discharges of stormwater. As there have been no observed flows, and analysis indicates that it would not occur, there is little opportunity for transport of site sediment with this pathway.

Sediment in the Portneuf River accumulates in point bars and chute bars downstream from the EMF study area, and upstream from the American Falls

Reservoir. Sediments also accumulate seasonally behind a small temporary irrigation-water diversion dam at Siphon Road. (This dam is removed each year to prevent damage during the high spring flows.) The annual and daily sediment load contributed by the Portneuf River to the American Falls Reservoir is a fraction (approximately 8 percent) of that contributed by the much larger Snake River, as illustrated in Figure 3.2-1.

Sediments were sampled along the Portneuf River at point and chute bars as illustrated in Figure 3.2-5. The three most downstream sediment samples were collected in the Fort Hall Bottoms near or just below the maximum high water mark of the American Falls Reservoir. Consequently, appropriate sediment accumulation areas have been sampled to detect historic potential releases from the EMF facilities. Sampling at locations further downstream would encounter sediments (and associated constituents) introduced by the Snake River. This would impair the ability to discern potential releases attributable to the EMF facilities (and other sources along the Portneuf River).

5.1.4 Groundwater Hydrology

Groundwater at the EMF facilities ranges from approximately 50 to 60 feet below ground surface (bgs) in the northwest portion of the study area to approximately 7.5 to 20 feet bgs in the northeast portion near the Portneuf River. Further south, the depth to water increases from over 100 to over 160 feet bgs. While the various saturated zones beneath the site are considered to be interconnected and, hence, one aquifer, the quality of the groundwater entering the study area from the south is highly variable.

Three natural groundwater types have been identified (see Figure 3.3-4):

- A sodium-calcium chloride system exists in the shallow zone in the west and north. In this report, this water is called the Michaud Flats groundwater regime. It flows from the west/southwest to the northeast.
- The Bannock Range groundwater regime has a calcium bicarbonate chemistry. Groundwater flow from this system enters the southern portion of the study area and flows north. It mixes in the shallow zone with the Michaud Flats water and the resulting mixed waters flow northeastward towards the Portneuf River; there is little mixing in the deeper zone.
- The Portneuf River Valley regime contains higher alkalinity groundwater. The flow direction of the Portneuf regime is northwest.

Section 5 Summary

The pattern of groundwater flow has been defined by measurement of potentiometric head from more than 100 observation wells over 6 to 12 quarterly measurements. These data, combined with measurements of hydraulic conductivity from slug tests and aquifer tests, have been used in an analytical modeling program (GWPath) to estimate the flow patterns and gradients shown in Figure 3.3-5.

- Groundwater enters the western portion of the EMF study area from the south (Bannock Range) and west/southwest (Michaud Flats). The hydraulic gradient is low, and a discharge/mixing zone is formed that flows northeast through the central portion of the FMC facility at a velocity ranging from approximately 0.5 to 1.5 feet per day.
- The central and eastern portions of the EMF study area contain mostly Bannock Range groundwater. Water movement is influenced by bedrock lows, groundwater levels within the gypsum stack, and the Simplot production wells, as well as interbedded soils and rock with widely different permeabilities. Flow direction in this area is generally north to northeast, except in local areas influenced by production wells. Groundwater velocities in this area range from 0.2 to 1.7 feet per day.
- Just to the north and east of the Simplot facility, the Michaud gravels of the Portneuf River Valley regime are a predominant influence on flow direction and velocity, due to their very high hydraulic conductivity. Flow velocities are estimated at greater than 12 feet per day in a northwest direction.

Measurements taken on the Portneuf River indicate that it is a gaining river downstream from Interstate 86 and a losing river upstream from this location. The pH of the river also changes from a value greater than 8 above the bridge to less than 8 (the same range found in groundwater) below it. In a losing river, groundwater is recharged by the river. In a gaining river, groundwater flows into the river. Therefore, water quality in the river upstream from Interstate 86 cannot be influenced by groundwater from the EMF facilities area.

A comparison of the general groundwater quality with river water quality indicates that the Portneuf River, even at downstream points, is similar to Portneuf River Valley groundwater, and dissimilar to Bannock Range and Michaud Flats groundwater. However, springs located on the western side of the Portneuf (Batiste, Papoose, and Twenty springs) consist of Bannock Range or a mixture of Bannock Range and Michaud Flats water. These observations indicate that the impact of these springs on Portneuf River water quality is small, despite their substantial volumetric discharge to the river.

5.1.5 Soils

Soils in the EMF study area originate from deposition by rivers and streams (sandy and gravelly alluvium), collection at the base of slopes (silty colluvium), weathering in place (residuum), and deposition by wind (silt loess). The distribution of these soils, which varies across the study area, is described in Section 5.1.2 (Geology) above. Generally, the southern portions of both the FMC and Simplot facilities are situated in loess and colluvium whereas alluvium and loess are the major soils under the northern portions of the facilities. Loess and alluvium are also found north of the facilities.

The naturally occurring soils on a large portion of both facilities have been modified over the years by either mixing with other soils or byproducts (such as slag) or by placing slag or other soils over them as fill, building foundations, embankments, or road surfaces.

The native silty soils are generally alkaline ($\text{pH} > 7$) due to their calcareous nature. This property limits the mobility of metals that might leach into them from overlying feedstocks, byproducts, and wastes. These soils also have relatively low vertical hydraulic conductivities in the range of 10^{-6} cm/sec or less. This property also serves to minimize potential infiltration of leachate to underlying groundwater.

5.1.6 Climate

The EMF study area is located in a semiarid area that averages approximately 11 inches of precipitation per year. Evapotranspiration has been calculated to be approximately 60 inches per year. Recharge from direct precipitation is low. Site-specific meteorological data have been recorded at two stations operated by Simplot for many years. Similar data have also been recorded at the nearby Pocatello airport. The maximum observed storm is 1.82 inches of rain within a 24-hour period.

The predominant wind direction is from the southwest, and the mean annual wind speed is approximately 10 miles per hour. Data from the Simplot stations show that the local topography of the Bannock Range influences wind direction in the vicinity of the facilities, causing a secondary predominance of winds from the southeast direction.

5.1.7 Demographic Data

The EMF study area encompasses both the FMC and Simplot facilities, portions of the cities of Pocatello and Chubbuck, unincorporated areas of Bannock and Power counties, portions of the Fort Hall Indian Reservation, and U.S. Bureau of Land

Section 5 Summary

Management lands. Land use in the area includes Fort Hall Indian Reservation (37 percent), U.S. Bureau of Land Management (13 percent), agricultural areas (6 percent), residential (10 percent), commercial (0.5 percent), and industrial and special use district (30.5 percent). FMC employs approximately 550 people, and Simplot employs approximately 460. Both facilities have implemented programs for worker safety to comply with or exceed Federal Occupational Safety and Health Administration (OSHA) requirements under 29 CFR 1910 and 1920.

The nearest residential development is approximately 1 mile east of the Simplot facility. The land use in near proximity to the facilities includes Interstate Highway 86, cattle grazing (in the southwest), farmland, and tracts of undeveloped land. Batiste Spring is a source of potable water for the Pocatello yard of the Union Pacific Railroad. The water is used predominantly for steam generation, and to a lesser extent, for drinking water.

There is limited public use of the lower portion of the Portneuf River due to limited access, although the Idaho Fish and Game Department has been stocking the river with rainbow trout. Public health warnings have been issued year-round advisories over the past four years advising avoidance of contact recreational activities due to E. coli contamination from unauthorized discharges from private sewage systems within the City of Pocatello upstream from the EMF facilities.

5.1.8 Ecological Characteristics

A survey of ecology in the EMF study area was performed as part of the RI. The aquatic species and habitats identified in the study area are described in the report.

Major terrestrial vegetation cover types and wildlife in the EMF study area include agriculture (40 percent), sagebrush steppe (37 percent), and wetland/riparian (3 percent). There are no important wildlife habitats present at the EMF facilities, and no critical habitats for threatened or endangered species, or special habitats, occur in the EMF study area.

The only significant aquatic habitat in the study area is the Portneuf River. The water quality has been reduced by numerous point and nonpoint sources discharging to the river. No endangered or threatened species occur in the portion of the Portneuf River within the study area.

5.2 SITE INVESTIGATION RESULTS

Previous investigations have been conducted in the EMF study area to characterize a variety of water resources issues, including both water quality and general water chemistry. Site-specific investigations have been conducted for groundwater and soils at the FMC facility and for groundwater at the Simplot facility. Previous investigations of offsite surface soils and vegetation have also been performed. Media investigated as part of area-wide studies include springs, groundwater, surface water, onsite soils, offsite soils, and river sediments. A comprehensive air pathways investigation is in progress. A brief review of these previous investigations is provided in Section 1.3 of the PSCS; greater detail on each previous investigation is presented in Appendix A.

As part of the Phase I and II investigations of the RI, 2,176 samples of groundwater, surface water, sediments, soils, and potential sources (defined as feedstocks, byproducts, and wastes associated with the industrial processes at FMC and Simplot) were collected. Each sample was analyzed, on average, for 48 individual constituents. These included inorganic constituents (metals, major common ions, nutrients), radionuclides, and (in many groundwater and soil samples) a variety of organic compounds. In all, there are 105,950 individual analytical results that occupy 2,716,371 fields within the electronic database compiled for the investigation. As a result of the data validation process, only 0.00004 percent of the analytical results were rejected due to various factors (laboratory error, lack of analytical precision, etc.).

5.2.1 Potential Sources of Constituents

Various waste management facilities and process operations were sampled to identify potential sources of historic and current releases at the facilities. At Simplot, these facilities included wastewater treatment impoundments and sediments, the drainage ditch leading to these impoundments, sediments and water from the east overflow pond, and gypsum and phosphate ore slurries. The FMC units included the calciner pond sludges, the current calciner pond sediments and water, water and slurries being discharged to the lined RCRA impoundments in the southwest of the facility, water and sediments from several of the operating impoundments, slag, and ferrophos byproducts. Additional source characterization is in progress as part of the air pathways investigation.

Observations from the potential sources characterizations include the following:

- The principal feed stock processed at the EMF facilities is phosphate rock mined from the Phosphoria Formation. This shale contains apatite, a mineral containing calcium, phosphate, and fluoride. The ore also contains

trace levels of arsenic, cadmium, chromium (total), vanadium, uranium-238 (and related decay isotopic products), zinc, and other elements. The processing operations at the EMF facilities separate these components into various products, byproducts, and wastes.

- A suite of characteristic constituents has been identified by concentration for major feed stocks, byproducts, and waste materials. The constituents found in the solid fraction of these materials at both FMC and Simplot are cadmium, chromium (total), fluoride, total phosphorus, vanadium, and zinc. Unless at least four of these constituents are present at above-representative concentrations in a soil or sediment sample, it is unlikely that the soil or sediment has been impacted by the EMF facilities.
- Specific feed stocks, byproducts, and wastes can be distinguished by characteristic levels of additional constituents. At FMC these include precipitator slurry and phosphy waste solids, containing characteristic levels of cadmium, lead, potassium, silver, and zinc; ferrophos, containing characteristic levels of chromium (total), iron, and vanadium; and calciner pond sediments, containing characteristic levels of fluoride, potassium, and selenium. At Simplot these include gypsum, containing characteristic levels of calcium, fluoride, total phosphorus, and sulfate.
- Characteristic constituents can also be associated with the aqueous fraction derived from potential sources. At FMC, these include total phosphorus in all materials; arsenic in phosphy water; arsenic and selenium in calciner wastewater; fluoride, zinc, gross alpha, and gross beta in precipitator slurry; and the absence of constituents above RCRA Toxicity Characteristic levels (using the Toxicity Characteristic Leaching Procedure) in slag. At Simplot, these include arsenic, calcium, sulfate, total phosphorus, and low pH in gypsum slurry, and a variety of process-related constituents and low pH in the former east overflow pond.

5.2.2 Groundwater

A total of 128 wells have been sampled over as many as five quarterly sampling events as part of the RI. These include 59 wells sampled at FMC (including 24 wells sampled under its RCRA groundwater monitoring program), 36 wells at Simplot, and 33 wells beyond the boundaries of the facilities. In addition, data for seven quarters of sampling (1990 through 1993) collected by FMC under its RCRA monitoring program have also been utilized. The monitoring well locations are shown in Figure 2.4-1.

Figures 4.4-1 through 4.4-5 display the concentrations of five major constituents (arsenic, total phosphorus, orthophosphate, sulfate, and pH) detected in groundwater.

Further evaluation of the hydraulic influence of potential sources and onsite pumping wells to groundwater flow patterns is in progress. The results of this study will be included in the RI Report. Until this evaluation is completed, it is premature to draw conclusions regarding the relative level of contribution from potential sources to the observed levels of constituents in offsite wells or in areas where flow from several areas has commingled.

This evaluation is being performed using analytical techniques. The major issues being studied are:

- Size of FMC and Simplot production well capture zones and their influence in controlling groundwater flow patterns.
- Delineation of groundwater flowpaths in the aquifer, focusing on the former FMC ponds, springs, the Portneuf River, and water supply production wells.
- Groundwater fluxes in the shallow saturated zone beneath FMC and Simplot, and a comparison of these fluxes with the flow rates in Batiste and Swanson Road Springs.
- The influence of bedrock topography on flow in the shallow and deep permeable zones.

The results will be evaluated to determine if there are critical data gaps that inhibit a full assessment of the relationship between potential sources and flow patterns within the EMF study area. If these exist, additional limited field study may be proposed to EPA.

Pending completion of this evaluation, the following conclusions can be made concerning the impact of the EMF facilities on groundwater quality:

- Shallow groundwater within the boundaries of the FMC and Simplot facilities has been impacted by releases from unlined waste management units at both FMC and Simplot. The constituents associated with this impact include arsenic, selenium, chloride, nitrate, total phosphorus, orthophosphate, and sulfate.
- Impacted groundwater that escapes capture by onsite production wells influences two springs near the Portneuf River (Batiste Spring and Swanson

Road Spring). Constituents detected in these springs were arsenic, sulfate, lithium, boron, and total phosphorus.

- Closures of unlined waste management facilities at both FMC and Simplot have greatly reduced releases of constituents of potential concern; these closures will lead to improved groundwater quality.

5.2.3 Onsite Soils

During Phase I, 86 locations at FMC and 72 locations at Simplot were selected for surface and subsurface soil sampling. These locations were chosen to investigate potential product and byproduct releases and to investigate the subsurface soil conditions in proximity to former unlined impoundments. As a result of the evaluation of the Phase I data, an additional six FMC sample locations and 10 Simplot locations were selected for investigation during Phase II to confirm trends. The locations of these sampling points are displayed in Figures 2.1-1 and 2.1-3.

Analysis of onsite soil samples indicates the following:

- Subsurface soil quality has been degraded only where either a sustained hydraulic head has transported constituents from source materials into underlying soils (e.g., former unlined ponds at FMC, gypsum stacks at Simplot), or where mechanical actions have mixed native soils with the source materials. Constituents present include cadmium, chromium, copper, lead, nickel, silver, vanadium, zinc, fluoride, phosphate, and sulfate. In some cases, soils impacted by this process act as secondary sources of constituent migration to groundwater.
- In cases where a sustained head is absent, constituents are largely immobile, unless they have been moved into subsurface soils through mechanical actions.

5.2.4 Offsite Soils

During Phase I, soil samples were collected at regular intervals along 16 radial transects from a centrally located position at the site (roughly every 23 degrees) up to a distance of approximately 4 miles (6.4 km). Four surficial (zero to 2-inch-deep) samples were taken and composited at each point, as well as one subsurface uncomposited sample (2 feet deep). Both types of samples were analyzed for inorganic constituents and radionuclides. After Phase I results were evaluated, an additional samples were taken during Phase II to confirm trends and establish background values (Figures 2.3-4 and 2.3-2). In all, a total of 108 locations were sampled.

Analysis of these offsite soil samples indicates the following:

- As expected, the highest concentrations of EMF-related constituents are found to the north and east of the facilities, where windblown ore has been deposited in a pattern consistent with the prevailing winds. Constituent concentrations decrease rapidly with increasing distance from the facilities.
- The distribution and concentration of constituents (fluoride, total phosphorus, zinc, and cadmium) along the 338-degree (north/northwest) radial suggests a nonfugitive dust EMF source. There may be other sources as well. Further investigation is being performed as part of the air pathways investigation.
- Offsite subsurface soils have not been impacted by airborne releases. An exception is in several samples taken near I-86 just north of the facilities, where mechanical turning of surface soils during highway construction may have introduced minor levels of constituents into the subsurface.
- Because overland flow (precipitation runoff) does not escape the boundaries of the facilities (see Section 3.2), air deposition or – in the case of slag – mechanical transport, the sole mechanisms for site-related materials outside the facilities' boundaries.

5.2.5 Surface Water and Sediments

Beginning in July 1992, 24 locations were sampled quarterly to evaluate surface water quality of the Portneuf River and contributing springs. The locations ranged from above the City of Pocatello to river mile 10 (see Figure 2.5-1). Sediment samples were collected from the bed of the Portneuf River and contributing springs at 24 of these locations. The texture of the sediment samples ranged from clays to sand and gravel, with most being fine-grained.

An additional six sediment samples were collected in December 1992 at the request of the EPA. Of these, three were collected in the Fort Hall Bottoms area. While an effort was made to collect these samples above the seasonal high water mark of the American Falls Reservoir, these sediments may still have originated from the Snake River, rather than from the Portneuf, because this area can be flooded during the maximum high water stage of the American Falls Reservoir. During such flooding, sediments introduced by the Snake River can be distributed anywhere over the flooded area from the mouth of the Portneuf as it flows into the American Falls Reservoir.

Section 5 Summary

Of the remaining three samples requested by the EPA, two were collected upstream from the EMF facilities, and the last was collected at river mile 10. In addition, during the last quarter of sampling, four additional surface water locations were sampled to assess preliminary conclusions drawn from the Phase I results.

River flow rates were measured quarterly for the study. An evaluation of the data indicates that, as anticipated, there is a very distinct high flow rate during spring runoff with moderate changes between July 1992, October 1992, and February 1993.

5.2.5.1 Results of Surface Water and Springs Investigations

Examination of trace metal and nutrient concentrations over four quarters of sampling indicates that there is no generalized enrichment of the surface water for any given parameter. Rather:

- There are specific points along the river where localized enrichment, followed by dilution, takes place. These points include the Pocatello sewage treatment plant discharge, the discharge point downstream from one of the fish farms (which also reflects a contribution from the STP), and the spring-fed pond at the FMC Park.
- During Phase I, enrichment was observed just downstream from the FMC outfall; sampling performed during Phase II did not detect any enrichment, however.

The water discharging from the springs follows a pattern similar to the river, with only localized impacts observed in the springs themselves or their reaches. A good example is Batiste Spring. EMF facilities-related impacts have been observed in the spring over the years and during the RI study period. However, a comparison of water quality at the mouth of the spring with that found in its drainage several hundred yards downstream shows a distinct drop in concentrations to levels characteristic of representative quality Bannock Range groundwater. This observation is an indication of dilution within the spring/groundwater system.

EMF-related impact was also observed at Swanson Road Spring. The remaining springs along the Portneuf River had no observable site-related impact.

5.2.5.2 Results of Sediment Investigation

The river sediment study arrived at the same conclusion as that made for the surface water. There are no observable general impacts on sediment quality from any given source on the river. There are local impacts from various anthropogenic activities. The only sediment sample that had the characteristic EMF-constituent associations was collected at station 17 (the FMC outfall). Samples collected over a

wider area at and just downstream from station 17 confirmed the presence of these constituents at the outfall and their absence at distances greater than 30 feet downstream.

There were other areas where one or several trace metals or nutrients were high, but did not display the characteristic associations of other chemicals. For example:

- The highest levels of lead in sediment were found upstream from the EMF study area and may be related to urban runoff or another NPL site in the area.
- Heavy metals were consistently high at location B1, a recreational boat launching area, and phosphate levels were high downstream from one of the fish farms at a likely deposition point for STP discharges.

The three samples taken at points believed to be above the seasonal high water level of the American Falls Reservoir in the Fort Hall Bottoms had trace metal values that were within the range of soil background levels found in the EMF study area. While there was some enrichment of calcium (shells were numerous in the samples) and phosphates, fluoride was not enriched. The deposition of the sediment loading of the Portneuf River system has not resulted in any observable impacts on the overall chemistry of its delta sediments.

There were several localized elevations of trace metals within the various spring system sediments, but there was no recognizable pattern. For example:

- Sediments at Batiste Spring had slightly elevated copper values, which may be attributable to the weathered aluminum/copper roofing at the spring house.
- Sediments at sample point 11 on the Batiste reach had elevated (107 mg/kg) zinc values but were at background for all other parameters.
- The sediments at the spring just south of the Pocatello Sewage Treatment Plant were high in lead, cadmium, and phosphates.

In summary, there does not appear to be any observable impact on the spring sediment system that can be directly attributed to EMF facilities operations.

5.2.6 Conclusions

The following overall conclusions can be drawn from analysis of the data collected during the RI.

1. Characteristics of potential sources of constituents (feedstocks, byproducts, wastes):

- Key constituents can be used to characterize the solid fractions of major potential source. The presence of these constituents in soils enable the source material to be assessed. This process was used to identify the presence of windblown phosphate ore in soils both within and beyond the boundaries of the facilities.
- Other sets of constituents can be used to characterize the leachable fraction of several potential sources. Some of these constituents are mobile (major anions such as sulfate and phosphate and the oxyanions arsenic and selenium). These constituents have been used to identify impact from phosphy waste ponds and the gypsum stack.
- Subsurface soil quality has been impacted only where either a sustained applied hydraulic head has transported constituents from source materials into underlying soils, or where mechanical actions have mixed native soils with the source materials.

2. Site-related constituents found in soils:

- The natural alkaline pH of soils is an important factor in attenuating metals (e.g., cadmium, chromium, lead) that were released from sources with applied head. The alkalinity also reduces the bioavailability of metals present in surface soils.
- Particulate releases (total phosphorus, fluoride, cadmium, chromium (total), vanadium, and zinc) have accumulated on the surface of soils up to approximately 1.5 miles from the facilities; this accumulation was likely caused by dispersal of phosphate ore particles during ore handling under past practices. This impact is seen in undisturbed soils; the concentrations of ore-related constituents are likely much lower in tilled areas. Process changes have been made at both plants in ore handling. At Simplot, ore is now transported to the plant by pipeline slurry, while at FMC, dust suppressants and specialized ore handling equipment are used to minimize the potential for dust generation and dispersal.
- Soils to the north/northwest of the facilities have probably been impacted by a nonfugitive dust release. This impact is seen beyond the zone of phosphate ore particle accumulation. The sources of such impacts are being investigated under the air pathways investigation.

- Subsurface soils beneath former unlined ponds (OS, OOS, 1-7S, and 1-6E) at FMC are secondary sources of constituent migration to groundwater, even though the applied head has been removed through closure of the ponds. However, the concentrations of site-related constituents leaching from these soils into groundwater are declining.

3. Site-related constituents in groundwater:

- The natural patterns of groundwater flow from the facilities is toward the east to northeast to the Portneuf River. There are two gravel layers in the aquifer beneath the facilities. Generally, the deeper zone has a higher potential head than the shallow zone, which inhibits constituent migration into the deeper zone.
- The shallow zone of the aquifer within the facilities' boundaries has been impacted by site-related constituents. However, this zone is not used as a source of drinking water.
- The Simplot water production wells exert significant control over groundwater flow patterns and constituent plume migration, but some flow (and minimal levels of site-related constituents) escape the zone of capture and can be detected at Batiste and Swanson Road springs. Further study is being performed to evaluate the zone of influence of these production wells, and the source areas not controlled by this zone.

4. Site-related constituents in surface water and surface water sediment:

- There is no indication of site-related impact downstream from the facilities. In addition, the exceedance of representative levels observed in samples of industrial discharge from the FMC outfall collected during Phase I of sampling was not seen in sampling performed during Phase II. The sediments collected at the mouth of this outfall contained particles of phosphate ore and precipitator dust or phossy waste solids; similar constituents were not found downstream. Further monitoring of the discharge will be done to confirm the absence of site-related constituents.
- The sediment samples collected during the study were obtained from locations likely to record past releases from the EMF facilities, based on the characteristics of the river and sediment deposition patterns. There is no reason to collect additional samples further downstream in the American Falls Reservoir. The overwhelming influence of sediment

loading from the Snake River, as well as contributions from other sources along the Portneuf River, would mask any historic contribution from the EMF facilities.

5. Overall conclusions:

- The RI has been successful in characterizing groundwater, soils, potential sources, surface water, and sediments.
- Further investigation of potential air pathways is ongoing.
- Based on the data obtained thus far, there are no immediate risks to human health or the environment.